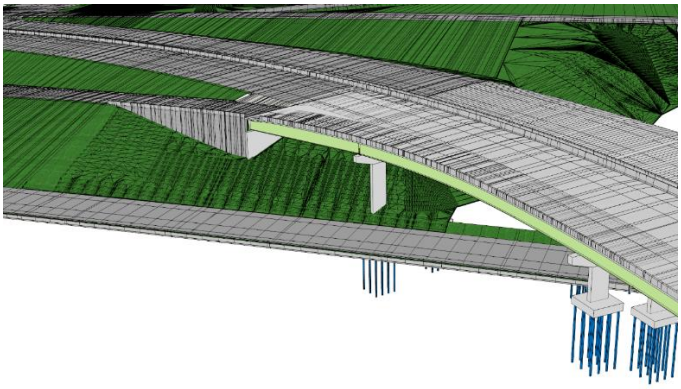

Digital Delivery

Interim Guidelines

Version 2.4

Digital Delivery Directive 2025

Pennsylvania Department of Transportation
February 28, 2023

REVISION HISTORY

Date	Author	Version	Changes
10/14/2021	HDR	Draft Final 1.0	
10/28/2021	HDR	Draft Final 1.1	Added line numbers for review comment log
4/15/2022	HDR	Draft Final 2.2	Major revisions throughout
8/22/2022	HDR	Draft Final 2.3	Major revisions throughout
2/28/2023	HDR	Version 2.4	Major revisions and additions throughout

Acronyms

Acronym	
AMG	Automated Machine Guidance
CADD	Computer Aided Design and Drafting
CDE	Common Data Environment
DDEP	Digital Delivery Execution Plan
DSC	District Survey Chief
EC	Engineering Confidence
EDD	Element Detail Designation
EG	Existing Ground
EGCL	Existing Ground Confidence Level
EID	Element Information Designation
EOR	Engineer of Record
GIS	Geographic Information System
LOD	Level of Development
MALD	Model as the Legal Document
MEBS	Model Element Breakdown Structure
NTP	Notice to Proceed
ORD	OpenRoads Designer Connect
OBM	OpenBridge Modeler
QC	Quality Control
WBS	Work Breakdown Structure

Table of Contents

Table of Figures and Tables

Chapter 1: Introduction

Objectives of Digital Delivery

In 2019, PennDOT issued a directive that by 2025, The Department will have the ability to submit designs digitally for bid utilizing project models instead of the traditional plan sheet-based format. Recent advances in software development and data standards provide opportunities to use digital delivery to increase design efficiency, better and more consistently communicate the design intent, more thoroughly review designs, and deliver more accessible information to construction.

In order to comply with the directive, PennDOT is using an incremental approach to modify standards and policies. This involves identifying discrete uses of digital delivery to pilot on design and construction projects. PennDOT will solicit feedback from pilot teams to update interim guidance and develop new or updated publications. These interim guidelines will be an important accompaniment to—but not replacement of—existing PennDOT publications.

Model as the Legal Document

Model as the Legal Document (MALD) is a form of digital delivery in which a model(s) comprises the primary construction contract document, preeminent in importance as defined by the Specifications or Special Provisions. This definition elevates the project design models, both 2D and 3D along with any related details and accompanying data further defining the project's design intent, to primary authority for construction. PennDOT projects designated as MALD will deliver all models and accompanying data digitally and will reduce the development of sheeted plans (22"x34") to specific submissions, such as right-of-way, as needed to comply with local agency requirements.

Purpose

It is important that project teams deliver a uniform application of digital delivery. The purpose of these interim guidelines is to assist project teams using digital delivery on pilot projects. This document will answer questions such as:

- Who is involved and what are their roles and responsibilities?
- Why digital delivery may be beneficial for a project?
- How to apply digital delivery to the project?
- When digital delivery will be used at specific project development milestones?
- What projects will have digital deliverables and what will be delivered using traditional plans?

The focus of this document is to provide an overview of key components of digital delivery and how to implement PennDOT's digital delivery policy on projects, including:

- Identify consumers of digital deliverables and their roles and responsibilities.
- Model development concepts.

- General modeling requirements for milestone deliverables.
- Model element breakdown standards.
- Digital delivery project management strategies.
- Project deliverables.

Note: This document is a living document and refined based on feedback from the pilot projects.

Organization of Document

This document is organized in eight chapters and several appendices; Introduction, Utilizing Digital Delivery on Projects, Model Development Concepts, Roadway and Bridge Milestone Modeling Requirements, Quality Management of Model Based Digital Deliverables, Use Case Guidance, and Digital Delivery Execution Plan Guidance.

Chapter 1- Introduction provides an overview of the document and how to use it.

Chapter 2 – Utilizing Digital Delivery on Projects provides an overview of the roles and responsibilities on a digital delivery project, model use cases, and the application of standards and workflows on PennDOT projects.

Chapter 3 - Model Development Concepts describes key terminology and workflows.

Chapter 4 - Design Milestone Modeling Requirements provides minimum modeling requirements information on the digital deliverables at each design milestone submission.

Chapter 5 – Bridges and Structures Milestone Modeling Requirements provides minimum modeling requirement information on the digital deliverables at each bridge milestone submission.

Chapter 6 – Quality Management describes how quality management is conducted for model-based deliverables.

Chapter 7 – Use Case Guidance provides guidance on uses cases such as preparing deliverables, design quantities, 3D coordination and clash detection, visualization, construction documents and digital as-builts information requirements.

Chapter 8 - Digital Delivery Execution Plan Guidance describes how to manage the model-based design development and digital deliverable creation processes using a digital delivery execution plan.

Appendices A-C provide additional guidance for modeling standards, model element breakdown structure, and process maps. Additional appendices will be added in future updates of this guideline.

How to Use This Guide

The interim guidelines provide direction and guidance to project delivery staff to plan, design and deliver projects using digital delivery processes and workflows. Table 1 provides a list of objectives and their location within this document.

Table 1. Guidance Objectives

Objective	Chapter
Obtain information about the digital deliverables to write a scope of work, including references to standards	1
Determine the project risks and understand how using digital delivery can help manage these risks.	2, 3, 6
Understand the digital deliverables at each milestone.	4, 5
Understand skill sets needed for project roles	2, 8
Obtain information needed to deliver the scope of work using design intent with digital deliverables.	4, 5
Learn how to create a strategy for federating multi-discipline designs, and facilitating interdisciplinary reviews using the model	6, 7
Learn about authorized uses and how it relates to model development standards and model progression.	2, 6, 8
Learn how to provide quality assurance to model based deliverables	6
Determine roles and responsibilities and how to execute responsibilities	2, 3, 8

References and Standards

The interim guidelines define specific requirements related to digital delivery for creating design model elements. It does not contain any information already described in other PennDOT publications related to Work Breakdown Structure (WBS), general project delivery references, or modeling standards. This section provides references to other PennDOT publications to be consulted during the design process and how they relate to digital delivery.

Work Breakdown Structure

During the scoping phase of a project, the WBS is to be modified to include digital deliverables. Additional information on how to include these deliverables is currently in development.

General Project Delivery References

The interim guidelines complement other PennDOT publications and provide additional context to define specific requirements related to digital delivery and 3D modeling standards. Existing PennDOT publications are the primary reference for any information relating to design standards and specifications, procedures, or deliverables, unless explicitly identified as a deviation in this guideline. Examples of these types of resources include:

- Publication 10 Design Manual Part 1 – Transportation Program Development and Project Delivery Process
- Publication 13 – Design Manual Part 2 – Contextual Roadway Design
- Publication 13M – Design Manual Part 2 – Highway Design
- Publication 15M – Design Manual Part 4 – Structures
- Publication 16 – Design Manual Part 5 – Utility Relocation
- Publication 122M – Surveying and Mapping Manual

Model Development Standards

The interim guidelines do not include any standards related to the PennDOT modeling software environment or required file format conventions. For specific information related to the modeling software standards used by PennDOT for digital delivery projects, refer to the following:

- Publication 14M – Design Manual 3 – Plans Presentation (Dual Unit)
- Publication 122M – Survey Manual
- Modeling Standards Manual

Glossary of Terms

Note: Many terms and acronyms are used throughout this document that may not be familiar. Please refer to the PennDOT's Digital Delivery Glossary as needed.

The PennDOT Glossary of Terms may be downloaded from the Digital Delivery Directive 2025 web page:

https://www.penndot.pa.gov/ProjectAndPrograms/3D2025/Pages/3D2025-Glossary-of-Terms.aspx

PennDOT Digital Delivery Website

For additional communication, resources, and information on the directive visit the PennDOT Directive 2025 website:

https://www.penndot.pa.gov/ProjectAndPrograms/3D2025/Pages/default.aspx

Chapter 2: Utilizing Digital Delivery on Projects

Digital delivery changes how designs are created, reviewed, and communicated through deliverables. While it can be applied wholesale, it is usually applied for specific purposes that serve project objectives. As such, it will be applied differently for different categories of projects.

Utilizing Digital Delivery on projects includes identifying new roles and responsibilities that designers, modelers, and managers will take on. Understanding the risks and developing mitigation strategies with the use of 3D model data prior to starting a project is crucial. This chapter covers how digital delivery use cases fit into project delivery, how project team roles and responsibilities shift, and how to apply digital delivery on the right projects and using the models for the correct application.

Application of Digital Delivery by Project Type

The following matrices identify the types of PennDOT projects with digital delivery requirements and 3D model based deliverables. The matrices are separated into the following categories:

- Typical Non-Complex Projects (Table 2)
- Typical Moderately Complex Projects (Table 3)
- Typical Most Complex Major Projects (Table 4)

Table 2. Typical Non-Complex Projects

Project Type	Model Use Cases									
	2D Data	Evaluate Use Cases	Existing Conditions Model	Design Authoring	Visualization	3D Coordination	Design Review	Design Estimate	Contract Documents	Digital As-Built
Roadway										
Maintenance Betterment	X									
3R (Resurface, Restore, Rehabilitate)*	X	X								
Turn Lanes at Intersections			X	X	X	X	X	X	X	X
Pavement and Shoulder Widening			X	X	X	X	X	X	X	X
Overlays and Simple Widening			X	X	X	X	X	X	X	X
Structures										
Bridge Resurfacing or Repairs (No Analysis)*	X									
Bridge Replacement (Minimal Approach Work)			X	X	X	X	X	X	X	X
Pipes and Box Culvert Replacement			X	X	X	X	X	X	X	X
Sign Structures			X	X	X	X	X	X	X	X
Noise/Retaining Walls			X	X	X	X	X	X	X	X
Highway Safety Improvements										
Guiderail*	X									X
Slope Flattening		X								
Traffic Operations—Signals		X								
Traffic Operations—Signing		X								
Traffic Operations—Pavement Markings	X									
Traffic Operations—Roadway Lighting		X								
Truck Escape Ramps			X	X	X	X	X	X	X	X

**Project type to include digital alignment data*

Table 3. Typical Moderately Complex Projects

Project Type	Model Use Cases									
	2D Data	Evaluate Use Cases	Existing Conditions Model	Design Authoring	Visualization	3D Coordination	Design Review	Design Estimate	Contract Documents	Digital As-Built
Roadway										
4R (Resurface, Restore, Rehabilitate, Reconstruct)			X	X	X	X	X	X	X	X
Minor Relocations and/or Reconstructions			X	X	X	X	X	X	X	X
Minor Sections with New Alignment			X	X	X	X	X	X	X	X
Intersection Improvements—Add Lanes			X	X	X	X	X	X	X	X
Intersection Improvements—Signal Layout Changes		X								
Roundabouts and Innovative Intersections			X	X	X	X	X	X	X	X
Structures										
Non-complex Bridge Replacements			X	X	X	X	X	X	X	X
Bridge Rehabilitation (re-analysis)		X								
Bridge Mounted Signs			X	X	X	X	X	X	X	X
Tie Back Walls			X	X	X	X	X	X	X	X
Sound Barriers			X	X	X	X	X	X	X	X
Proprietary/Mon-Proprietary Walls			X	X	X	X	X	X	X	X

Table 4. Typical Most Complex (Major) Projects

Project Type	Model Use Cases									
	2D Data	Evaluate Use Cases	Existing Conditions Model	Design Authoring	Visualization	3D Coordination	Design Review	Design Estimate	Contract Documents	Digital As-Built
Roadway										
New Highways			X	X	X	X	X	X	X	X
New Interchanges			X	X	X	X	X	X	X	X
Major Relocations			X	X	X	X	X	X	X	X
Capacity Adding/Major Widening			X	X	X	X	X	X	X	X
Major Reconstruction			X	X	X	X	X	X	X	X
Structures										
Replacement or New Unusual/Complex/Major (Federal) Structure			X	X	X	X	X	X	X	X
Rehabilitation of Unusual/Complex/Major (Federal) Structure		X								
Unusual Geology		X								

Roles and Responsibilities

Digital delivery increases the importance of clarifying and formalizing responsibilities for managing, creating, and using the model(s). Project teams may wish to formalize roles or assign the responsibilities to existing team roles. These key roles and responsibilities are described herein.

- Figure 1 documents the roles and responsibilities for a Typical Most Complex project type.
- Figure 2 documents the roles and responsibilities for a Typical Moderately Complex project type.
- Figure 3 documents the roles and responsibilities for a Typical Non-Complex project type.
- Table 5 provides a description of responsibilities for each role. It is important to know that depending on the project size role titles may defer from the table and multiple role responsibilities may be held by the same person.

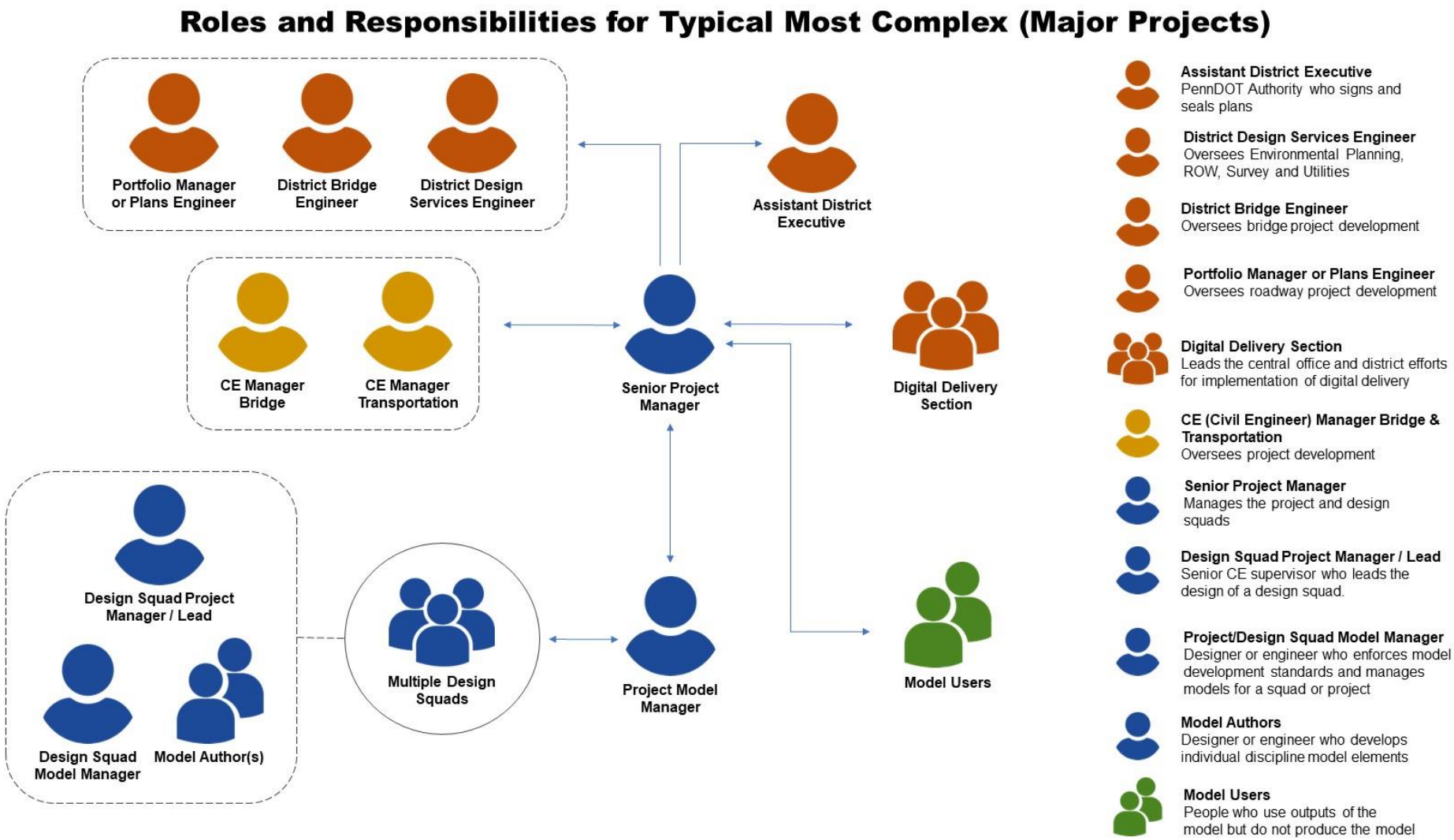

Figure 1. Roles and Responsibilities for Typical Most Complex Projects

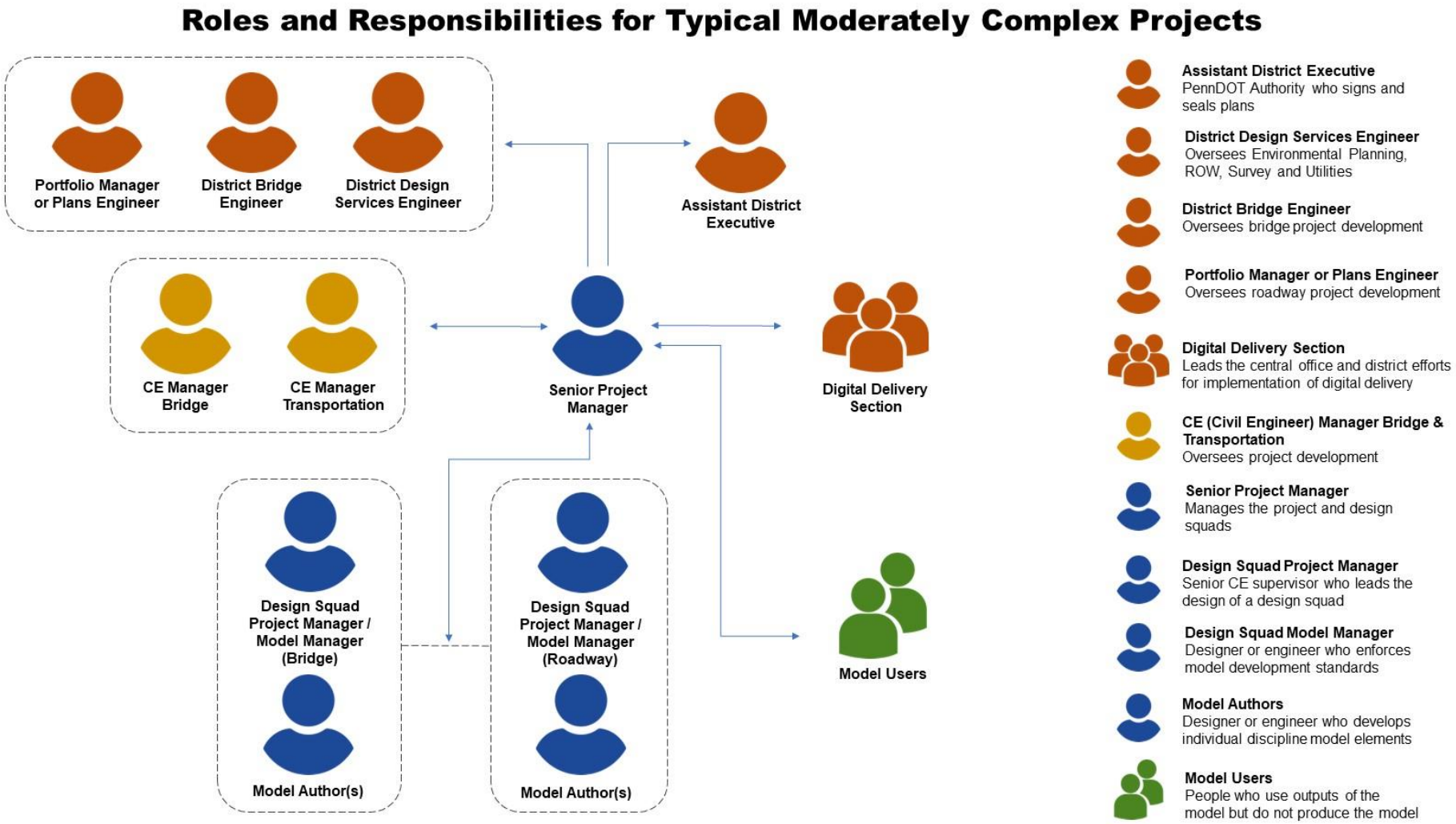

Figure 2. Roles and Responsibilities for Typical Moderately Complex Projects

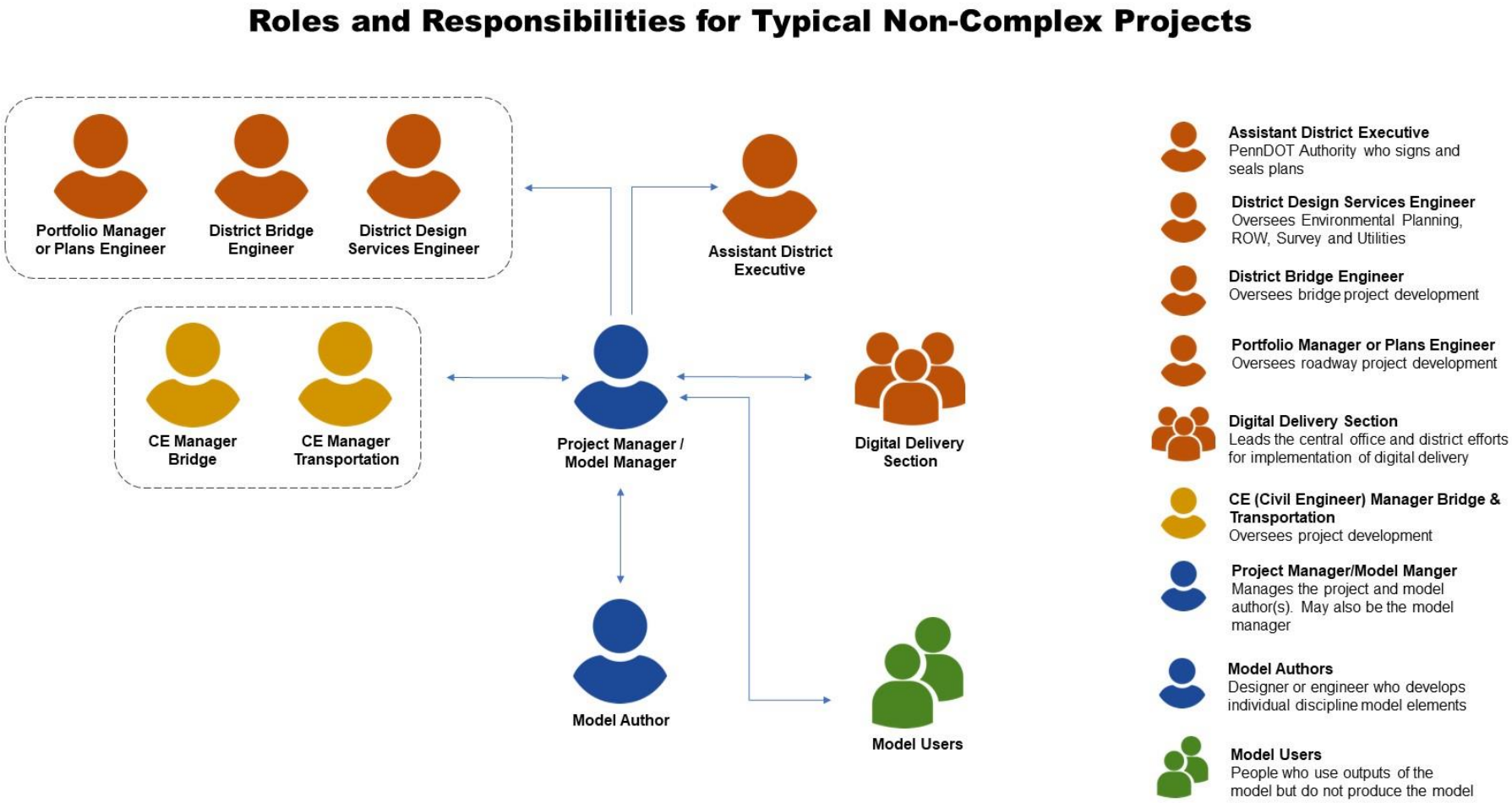

Figure 3. Roles and Responsibilities for Typical Non-Complex Projects

Table 5. Project Roles and Responsibilities

Role name	Description	Responsibilities
Digital Delivery Section	• PennDOT Employee • Typical on all project types • Competencies needed to fulfill this role: understanding of the PennDOT project development process, digital delivery practices and technology (e.g., ProjectWise, Bluebeam, iTwin Design Review, ORD, OBM) being used	• Develops and updates the DDEP template and checks in with the digital delivery team to document progress and lessons learned. • Assists project teams interpreting design delivery requirements. • Provides technical assistance to the project teams. • Assists the senior project managers, project managers and project model managers with setting up training and technical support.
Senior Project Manager	• PennDOT Employee • Typical on Most Complex and Moderately Complex projects	• Communicates the digital delivery requirements to the consultant project manager or the design squads • Works closely with the project squads/teams to ensure quality of the deliverables. • For district designed projects, the senior project manager works with the design squads to develop a DDEP. • For consultant designed projects, the consultant project manager provides the Department a DDEP describing how the team plans to meet the digital delivery requirements. • Coordinates with project model manager for distribution of deliverables. • Performs design compliance reviews using review software such as iTwin Design Review.
Project Manager	• PennDOT or Consultant • Typical on Non-Complex projects or Consultant led projects	• Works closely with the project squads/teams to ensure quality of the deliverables. • For district designed projects, the project manager works with the project team to develop a DDEP. • For consultant designed projects, the consultant project manager provides the Department a DDEP describing how the team plans to meet the digital delivery requirements. • Coordinates with project model manager for distribution of deliverables. • Performs design compliance reviews using review software such as iTwin Design Review.

Project Model Manager	• PennDOT or Consultant
	• Typical on all project types
	• Competencies needed to fulfill this role: knowledge of the digital delivery process and workflows to perform specific technical tasks, and experience in using the modeling software to federate the models (e.g., ORD), perform clash detection (e.g., ORD. iTwin Design Review), and manage project files (e.g., ProjectWise administration).
		• Liaise with the Digital Delivery Section to clarify the requirements with managing and executing the digital delivery processes for the project(s) for which they are responsible.
		• Takes an active role in assisting the senior project manager or project manager with the development and execution of the DDEP.
		• Coordinates file management with each design squad or discipline lead.
		• Educates project team members regarding digital delivery processes and expectations.
		• Facilitates and enforces the protocols established for each of the following:
		  • Verify coordinate systems and other file settings are set up appropriately.
		  • Verify PennDOT model standards are being followed, such as feature definitions and file naming conventions.
		  • Managing common data environment, such as access rights to project file locations.
		  • Performs clash detection and produces clash detection report.

		• Coordinates the submission and exchanges of models. • Maintains model archives. • Prepares bid model package for design reviews and contract management delivery. • Perform quality control (QC) of the design model against the design criteria and model element breakdown structure (MEBS) criteria. • *This is a new role specific to digital delivery. Training may be needed to elevate an experienced modeler or someone with the aptitude and strong desire to learn new technology to take on this role. This role may be fulfilled by someone who has provided CADD management support in the past at the district level.*
Design Squad/Discipline Lead	• PennDOT, consultant or subconsultant • Typical on Most Complex and Moderately Complex projects • Engineer responsible for supervising the design squad for a specific discipline. This person may or may not be well verse in developing models • Competencies to fulfill this role: knowledge of the project development process and discipline-specific design criteria.	• Works with the design squad/discipline model manager to direct the development of discipline-specific model elements to the level of development as defined for the pilot projects. • Work with the design squad/discipline model manager to review the design criteria and model deliverables. • Monitor and resolve design issues.
Design Squad/Discipline Model Manager	• PennDOT, consultant or subconsultant • Typical on Most Complex and Moderately Complex projects • Competencies needed to fulfill this role: knowledge of the digital delivery and project development process, discipline-specific design criteria, and model authoring software (e.g., ORD or OBM).	• Provides training and technical support for the design squad/discipline model authoring. • Enforces modeling standards and performs quality control of model deliverables for the specific discipline. • Works with design squad/discipline lead to perform design and model deliverables reviews. • Leads design squad/discipline model authoring and assists individual Model Authors in developing model elements • Perform quality control (QC) of the design model against the design criteria and model element breakdown structure (MEBS) criteria. • *Traditionally, this has been the discipline designer/engineer that has used the design software to develop plan sheets (e.g. InRoads and MicroStation). Training may be needed to elevate an experienced modeler or someone with the aptitude and strong desire to learn new technology to take on this role. This role may be fulfilled by someone who has developed corridor models using InRoads before, designed 3D solids, or a tech-savvy designer/engineer being pro-active in learning the new modeling software (e.g. ORD or OBD).*
Model Author (Designer/Engineer)	• PennDOT, consultant or subconsultant • Typical on all project types • Competencies to fulfill this role: Knowledge of modeling software (e.g., ORD, OBD) to create the discipline-specific model elements. • Knowledge of the PennDOT project development requirements for specific discipline (Design, Structures, Hydrology and Hydraulics).	• Develop discipline-specific model elements to the level of development as defined for the pilot projects. • Perform quality control (QC) of the design model against the design criteria and model element breakdown structure (MEBS) criteria. • *It is assumed that the project may have multiple model authors.*

Model User	• PennDOT, consultant or subconsultant
	• Typical on all project types
	• A model user is anyone who will consume the digital design information contained in the model(s).
	• Competencies to fulfill this role may vary depending on the function of the job tasks needed to be perform, but may include:
	  • Understand how to extract information from the model being received.
	  • Knowledge of model level of development, authorized uses and limitation of the model being received.
	  • Ability to use the software being used to conduct the specific task, for example a structural engineer needs to be well versed in OBM but may not need to know ORD to reference a roadway model to their bridge model.
		• Project managers or plan engineers whose responsibility is to perform quality reviews.
		• Other discipline designers/modelers who reference models produced by someone else.
		• Construction inspection staff who reference the model to verify construction outcomes and final quantities for payment.
		• Contractors who use the bid model to prepare bids, plan means and methods, and construct the project.

Digital Delivery Model Use Cases

A model use case determines what the project model(s) must be used for and thus defines the level at which the model or collection of models must be capable of performing. For example, if a model use case of Design Quantities is specified then the model must contain ample information and detail to provide the correct quantification for each pay item. Each specific model use case is selected based on the goals of the project and may be used over multiple phases of a project. PennDOT and its consultants, may require different model use cases than Construction due to each entity having different objectives. Not all use cases may be used on a project.

Table 6 descibes the type, phase and potential duration of the model use cases that PennDOT has prioritized as a standard policy for digital delivery.

Table 6: Model Use Cases through the Project Development Cycle

<table>
<tr><th>Planning</th><th>Design</th><th>Letting</th><th>Construction</th></tr>
<tr><td colspan="2">Existing Conditions Modeling</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td colspan="2">Design Authoring</td></tr>
<tr><td colspan="2">Visualization</td><td colspan="2">Visualization</td></tr>
<tr><td></td><td rowspan="2">3D Coordination
Clash Detection</td><td colspan="2">3D Coordination</td></tr>
<tr><td></td><td colspan="2">Construction Planning</td></tr>
<tr><td></td><td>Design Model Review</td><td></td><td>Construction Documentation</td></tr>
<tr><td></td><td>Design Quantities</td><td>Estimating</td><td rowspan="2">Quantity Takeoff And Estimating</td></tr>
<tr><td></td><td colspan="2">Contract Documents</td></tr>
<tr><td></td><td>Temporary Construction Model</td><td></td><td>Shop Model (Drawing) Authoring</td></tr>
<tr><td></td><td></td><td></td><td>Shop Model (Drawing) Review</td></tr>
<tr><td></td><td></td><td></td><td>Construction Layout</td></tr>
<tr><td></td><td></td><td></td><td rowspan="2">Digital As Built (Record Model)</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td rowspan="2">Inspection, Verification and Acceptance</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Key:</td><td>PennDOT Use</td><td>Contractor Use</td><td></td></tr>
</table>

Prerequisite Model Use Cases

To use digital data in the project delivery process, there are two types of models that need to be developed: existing conditions and design models. These two types of models are required to use digital data for most of the PennDOT model uses described in this section. Below is a description for each of these two types of models.

EXISTING CONDITIONS MODELING

A process to document the existing conditions for a project to form the basis of design and/or construction. Existing conditions may include the existing ground surface, surface features (e.g., edges of pavement), surface assets (e.g., signs, lighting, striping), land boundary information (e.g., right-of-way, legal boundaries, and property corners), subsurface utilities, structures, and subsurface features (e.g., ground characterization and the existing pavement layers). The digital data may include 2D and 3D geometry, GIS derived information, documents, images, and analytical models (e.g., geotechnical). It is important to recognize that all elements depicted in existing conditions models carry uncertainty regarding their location and characterization. Model users need to be familiar with the various confidence intervals for all depicted model elements, especially subsurface features.

DESIGN AUTHORING (ROADWAY, BRIDGE AND DRAINAGE)

The process of developing a model to define and document the design. Typically, each individual discipline (e.g., roadway, structures, and drainage) develops a discipline model using a common coordinate reference frame. The individual discipline models are then referenced together into a single, federated model. This is an essential model use case to support many downstream uses, including model as the contract document. Element detail and information increases from conceptual to final design as the project is being designed.

Model Use Cases

During the life of a highway infrastructure project, there is a significant amount of information that needs to be exchanged between stakeholders and milestones during project development. Digital delivery is a modernized approach to project delivery processes and contract media that incorporates digital data. Simply stated, construction projects have the ability to be bid using 2D and 3D technology and no longer only be delivered in a traditional construction plan format. The specific type of information needed by each model user to conduct their job tasks is described as a model use. Each model use is based on the needs of the recipient (model user), including model-based and other digital information exchanges. Details about the required model uses for digital delivery are described in this section.

VISUALIZATION

The process of creating visual representations of the project to communicate with technical and non-technical stakeholders throughout the project lifecycle (e.g., scoping, NEPA, stakeholder involvement). The digital data includes 3D model renditions, raster files, and video simulations. The graphical detail and information associated with these models is dependent on when the visualization products are created. If the visualization is to produce products for public information as the project enters final design, the base model may have a high level of detail, but little or no engineering information.

DESIGN MODEL REVIEW

The process of reviewing the design to determine compliance with codes and guidelines. Design review may include the use of software to analyze design models using a rule set that checks design criteria requirements, as well as the outputs of analytical design and 3D coordination. Design review is the responsibility of specific project stakeholders, such as the

Engineer of Record (EOR) and a designated design reviewer. Often, the EOR and design reviewer are responsible for specific discipline models. There are additional design review procedures for federally funded projects. The digital data includes 2D and 3D geometry, analytical models, and documents (i.e., reports). The model elements may have variable level of detail and information depending on when the design review is being performed.

DESIGN QUANTITIES

The process of taking off quantities from the design model according to a schedule of bid items and estimating a price for each bid item to estimate the construction cost. The model elements may have variable level of detail and information depending on when the design quantities are being developed. However, the final design quantities and engineer's estimates for final deliverables are derived from a model with a high level of detail and information.

TEMPORARY CONSTRUCTION MODEL

The process of developing a model for the design of temporary construction systems, such as staging, temporary utilities, excavation, or other engineered temporary construction systems. These models can be utilized during 3D coordination and clash detection to make appropriate construction decisions through detailed analysis. The model elements may have variable level of detail and information depending on the level of need to make appropriate decisions.

3D COORDINATION AND CLASH DETECTION

The process of using software to analyze a federated model of design models using rule sets to identify collisions between design elements. 3D coordination also includes performing a visual analysis to identify potential spatial design and staging issues. 3D coordination and clash detection may include comparisons between both existing conditions modeling and proposed models, and interdisciplinary design model coordination to proactively avoid collisions in the design authoring process. Analysis using existing conditions models needs to consider the accuracy of the model source data. The digital data includes GIS, 2D and 3D geometry and documents (i.e., collision reports). The model elements may have variable level of detail and information depending on when the 3D coordination or clash detection is being performed. However, it is important to recognize that the more detail and information available, the better the reliability of the 3D coordination and clash detection.

DIGITAL DELIVERY CONTRACT DOCUMENTS (LETTING MODEL)

The process of documenting the existing conditions, design intent, construction specifications, and engineer's estimate for the purposes of bidding and construction. Currently, the process uses documents such as plans, specifications, and spreadsheets. With digital delivery, most plans will be replaced with digital data, which may comprise of 2D and 3D model geometry and documents like spreadsheets with tables of data or 2D project PDF files (e.g., digital roll plots). The "letting model(s)" delivered as the contract document is at high level of detail and information.

CONSTRUCTION INSPECTION, VERIFICATION AND ACCEPTANCE

The process by which a construction inspector uses the contract bid model to verify, document and accept construction outcomes.

CONSTRUCTION PLANNING
The process by which the contractor determines means and methods for constructing the project, which may include scheduling, workforce planning, equipment selection, etc.

CONTRACTOR QUANTITY TAKEOFFS AND ESTIMATING
The process by which the contractor extracts information from the design model to verify pay item quantities and to prepare bids, order materials, and schedule crews.

CONSTRUCTION LAYOUT
The process by which the contractor extracts information from the design model to lay out the work on site, including setting local survey control points and the use of Automated Machine Guidance (AMG).

SHOP MODEL (DRAWING) AUTHORING
The process by which the fabricator develops and documents the fabrication information.

SHOP MODEL (DRAWING) REVIEW
The process by which the Contractor and Resident Engineer provides shop model (drawing) and RFI submissions to PennDOT.

DIGITAL AS BUILT (RECORD MODEL)
The process of documenting any significant changes to the constructed condition compared to the contract (bid) model. With digital delivery, the design models and shop models could be updated to reflect the as built condition and may be supplemented with digital data represented in spreadsheets or other digital file(s). The digital data includes GIS attributes, 2D/3D geometry, documents, photographs and/or videos. This data model concludes the digital project delivery phase and constitutes the “handoff” model for post-construction operations.

Chapter 3: Model Development Concepts

Overview

Model development standards communicate the expectations for creating model deliverables at each milestone of the design process. Just as PennDOT has standards that define the requirements for what type of information goes in every type of plan sheet PennDOT is establishing modeling development standards to define the requirements for modeling projects in 3D. Without these standards, it is difficult to predict what information can be relied upon in a 3D model. Creating 3D models that meet the defined standards ensures that the design intent of the model is portrayed correctly and can be utilized for different use cases. These 3D models will communicate the design intent that previously was communicated on plan sheets. In addition, the PennDOT modeling development standards will communicate to contractors the reliability and authorized uses for the delivered digital design models. Also, 3D design review requirements are being developed based on these modeling concepts.

Model development concepts need to consider how to mitigate new risks associated with model-based deliverables, how to standardize processes and detail how the information will be managed. This chapter will cover specific risk management topics, the PennDOT modeling development standards and design information management.

Risk Management

Existing Ground Confidence Level

Existing Ground (EG) models control the accuracy of how the final design model will tie into the existing ground during construction and the accuracy of the estimated earthwork quantities. It is important for the designer to understand the quality of the EG both in terms of accuracy and density. In the areas in which the design is determined by immovable physical features (e.g., bridge abutment, existing hard surfaces, bridge clearance), the models need to be depicted with high accuracy. See Figure 4 for an illustration of how the intended design impacts the Existing Ground Confidence Level (ECGL) that is needed.

Figure 4. Example of various situations requiring different accuracy.

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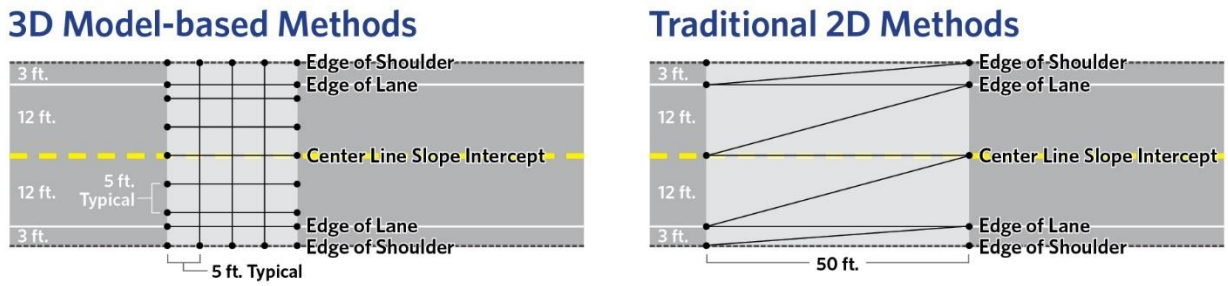
While EGCL is not a new concept to design, it is critical to digital delivery to define and document the survey accuracy of all survey collected on a project. The designer is to work closely with the survey team when making decisions regarding accuracy needs and appropriate data collection methods. This is to manage those areas and situations with the most risk. Collaboration between design and survey must take place as early as possible in the project lifecycle. The surveyor may recommend a data fusion approach to manage the cost of data collection.

The designer is to identify the areas of high-risk situations in which the accuracy of the EG may have significant impacts to the project budget, timeline, or both. It is also important to note that there are different acceptable accuracy thresholds for soft surfaces, sensitive features like wetlands, and hard tie-ins like pavements and structures. For pavement reconstruction projects, the accuracy of the EG will also affect the accuracy of the material quantities and any slope correction designs.

Digital Delivery projects may require a higher density of data collection for EG models than traditional plan delivery. Traditional survey data collection methods support cross-section design models, which are only accurate at the interval shown in the plans (e.g.,50-ft). The EG point density determines the amount of interpolation when developing the design model, which contributes to the level of uncertainty of the quantities and success of final design. A higher density EG model is needed for model as legal document to enable the design team to sufficiently reduce the associated risk with the uncertainty of the design model interpolation as shown in Figure 5.

Figure 5. Example of design 3D model-based vs. traditional 2D data cross-section density.

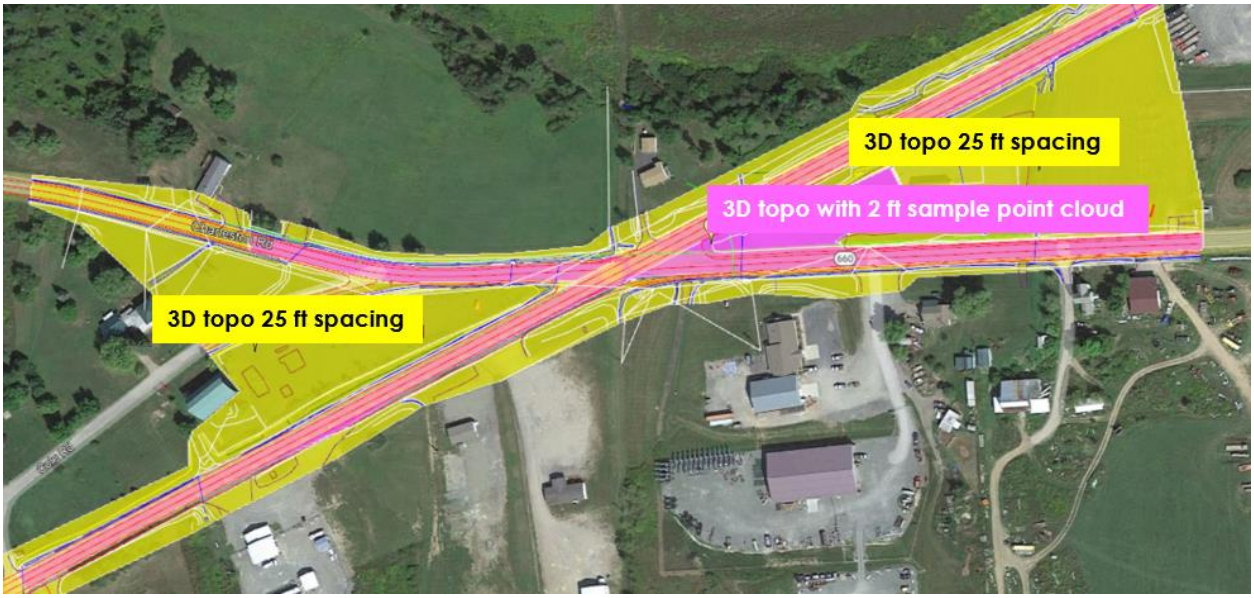


Maier et. al. 2017

The designer is to work closely with the survey team when making decisions regarding accuracy needs and appropriate data collection methods to manage those areas and situations with the most risk. The surveyor may recommend a data fusion approach to manage the cost of data collection. The original survey may have been completed using 25-ft cross section data collection method and supplemented with 2-ft sample point-cloud data (Figure 6).

As a rule of thumb, existing terrain models point density have twice the density of the proposed design model template drop intervals. For example, if the design requires a 5-ft template drop interval, a minimum 2-ft point density grid is recommended for the existing terrain model.

Figure 6. Example of data fusion

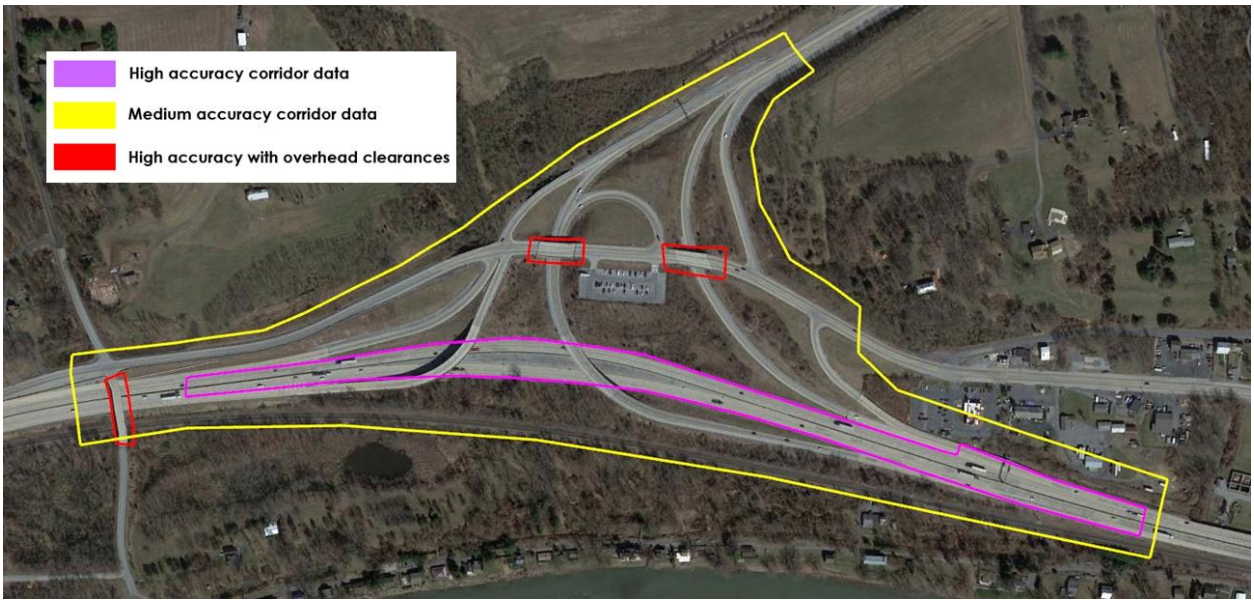


REQUESTING UPDATED SURVEY MODELS

The design team and District Survey Chief (DSC) work together to discuss options for attaining the required accuracy and density to support digital delivery. The DSC determines the best data collection method and works with the Central Office Photogrammetry and Survey Section to determine best practices for post-processing point-cloud data to optimize the resulting existing terrain model; and fusing data sets or combining individual models into a complex terrain model in ORD (Figure 7). High accuracy data may need to be collected with Lidar technology. For

additional information on PennDOT EGCL accuracy levels that support digital delivery see PennDOT Publication 122M and contact Central Office Photogrammetry and Survey Section.

Figure 7. Example of various accuracy needs for digital delivery.



Note: *The data to create existing terrain models to support digital delivery will be collected using a variety of technologies to achieve desired accuracies and densities to minimize uncertainty. It is expected that project data sets will be complex terrains made from individual terrains processed at different accuracies and point densities as shown in Figure 7.*

Geotechnical Risks

This section will be updated in the future with the reliability of modeled geotechnical layers based on the geotechnical report produced through design. It is important to note that the primary information source of geotechnical data is the geotechnical report where the engineer has provided their analysis.

Subsurface Utility Engineering Risks

Subsurface utility engineering (SUE) involves managing risks associated with locating, relocating, and mapping utilities. A number of standards have been developed to maintain the use of SUE. ASCE 38-22 (Standard Guideline For Investigating And Documenting Existing Utilities) outlines the recommended process for locating and documenting underground utility facilities as applied to infrastructure planning and design activities. ASCE 38-22 includes a system to classify the quality of existing SUE data with four quality levels: QL-A through QL-D. This is an update to ASCE 38-02, which was published in 2003.

For digital delivery projects, project teams will need to manage additional risks on existing utility modeled accuracy. The PennDOT Digital Delivery team is currently working on processes and workflows to document, model and deliver existing subsurface utilities.

The team is also reviewing ASCE 75-22 (Standard Guideline for Recording and Exchanging Utility Infrastructure Data) to develop processes and workflows to model proposed subsurface utility systems. This will include the development of agency standards for designing, constructing, and obtaining SUE digital-as builts during inspection. The benefits of applying these standards of care include effective utility data exchanges between stakeholders, consistency between projects and more effective utility asset management.

Additional information about SUE existing and proposed modeling for design and construction is currently being developed.

Common Data Environment

A Common Data Environment (CDE) is a service that collects, stores, manages and shares information through a managed process. Implementing a common data environment enhances collaboration and creates a single source of truth for the data and information developed on a project. A CDE improves efficiency and quality of project information and reduces the manual rework found in sheet-based design. PennDOT's CDE for model-based files is Bentley's ProjectWise. Refer to PennDOT's ProjectWise requirements for additional information.

Model Development Standards

Model development standards rely on three basic principles:

- Engineering confidence
- Level of detail for each model element
- Information (data) to be associated with each model element

These principles are centered on the Level of Development (LOD) of each element. As a minimum requirement within a model, the LOD is defined by the level of detail and the level of information of an element. LOD can be classified in four levels, which equate to the degree to which an element's geometry (detail) and associated information have been defined. To explain how this works, we'll use a piece of fruit; the LOD Kiwi (Figure 8) to describe the level of detail and level of information.

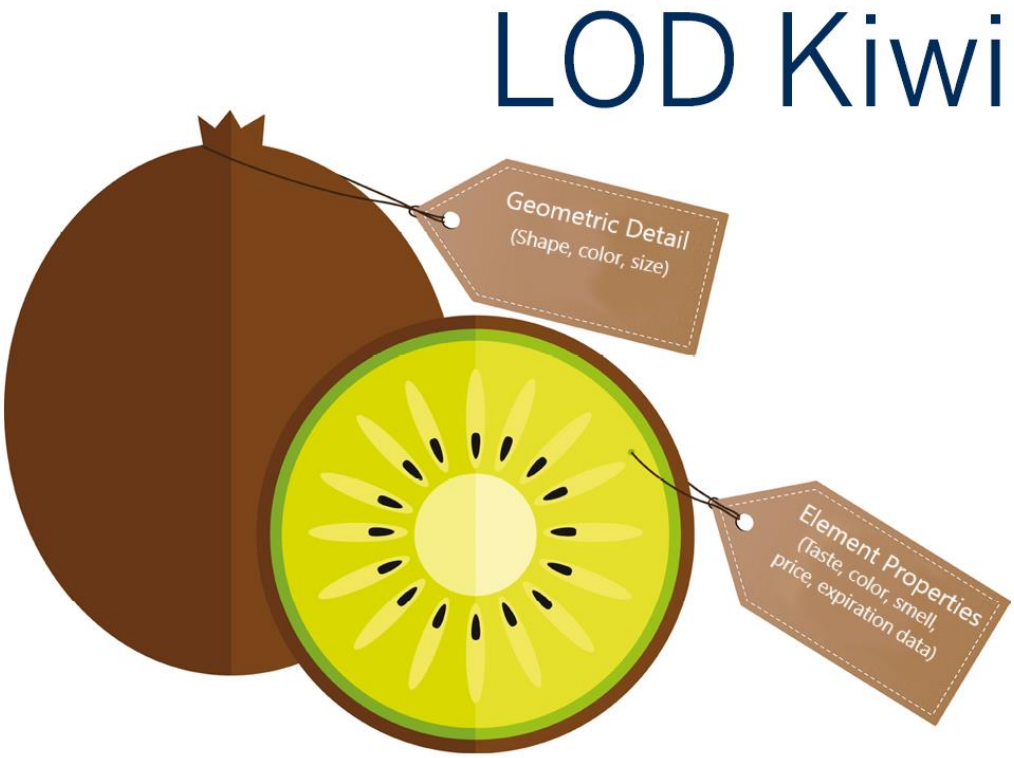


Figure 8. LOD Kiwi

For this example, the outside of the kiwi represents the detail while the inside represents the information.

The outside, which is visible, tells us something about the appearance (or geometry) of the element, such as shape and color. The detail is distinguished between 4 different levels, where the first level is schematic in detail and the fourth level is highly detailed.

The inside, which is not visible, tells us something about information associated with the kiwi such as the smell, taste, texture, and color. The information is distinguished between 4 different levels varying in the amount of information associated with the element.

Being able to define the level of detail and level of information for any given element, at any milestone submission, allows us to have a consistent understanding of what is being provided.

LOD is tied to various risk management topics such as Existing Ground Confidence Level (EGCL) and geotechnical and subsurface utility risks. Understanding how to manage the risk within a model helps manage expectations and provides the ability to communicate design intent of any given model.

Engineering Confidence

Engineering Confidence (EC) is the amount of certainty of the design intent behind the model deliverables. Engineering confidence communicates level of completion of engineering calculations, selection of material and feature types and their location of the modeled elements for milestone deliverables. The EC is typically associated with design criteria requirements for specific milestone deliverables, which determines the authorized uses for the model. Refer to the appropriate PennDOT Publications for specific design criteria and milestone approval requirements. Table 7 provides a summary of general engineering confidence description and authorized uses for each design milestone deliverable.

Table 7. PennDOT Design Model Authorized Uses per Milestone Deliverables

Milestone Deliverable	*Definition*	*Potential Authorized Uses*
Line, Grade and Typical Section (LG&TS)	Model element engineering confidence is approximately 30-50% Design is partially developed to depict preliminary engineering intent, but many engineering decisions have not been made.	Preliminary design approval Existing Condition Modeling Design Authoring Preliminary 3D Coordination/ Clash Detection Preliminary Design Quantities Visualization
Hydraulics and Hydrologic (H&H) Report	Model element engineering confidence for bridges and structures is 20-30%. Design is developed to a level that can meet the H&H permitting requirements. Model refinement in subsequent deliverables should have limited to no impact on permitting.	Permitting Existing Condition Modeling Design Authoring Preliminary 3D Coordination/ Clash Detection Preliminary Design Quantities Visualization
Type, Size and Location (TS&L)	Model element engineering confidence for bridges and structures is approximately 30-50%. Design is partially developed to depict preliminary engineering intent, but many engineering decisions have not been made.	Preliminary design approval Existing Condition Modeling Design Authoring Preliminary 3D Coordination/ Clash Detection Preliminary Design Quantities Visualization

Design Field View (DFV)	Model element engineering confidence is approximately 50-75% Design is transitioning from preliminary to final engineering intent, but some engineering decisions are still being finalized	Preliminary design approval Existing Condition Modeling Design Authoring 3D Coordination/ Clash Detection Preliminary Design Quantities Visualization
Foundation Submission	Model element engineering confidence for foundation elements is approximately 90-100%. Model element engineering confidence for remaining structure is approximately 60-90%.	Preliminary design approval Existing Condition Modeling Design Authoring 3D Coordination/ Clash Detection Engineer's Estimate Visualization
Final Design Office Meeting (FDOM) or Constructability Review	Model element engineering confidence is 90-100% Design intent is fully developed but some conditions require field verification for final construction	Final design approval Existing Condition Modeling Design Authoring 3D Coordination/ Clash Detection Design Quantities Visualization Engineer's Estimate
Plan, Specification and Estimate (PS&E)	Model element engineering confidence is 100% Design intent is fully represented, and conditions have been field verified	Final design approval Existing Condition Modeling Design Authoring 3D Coordination/ Clash Detection Design Quantities Visualization Engineer's Estimate Contract Documents

Note: *Each design element will be noted with its specific Detail and Information designation, as well as any exceptions and limitations for its authorized uses. The detail and information designated will be noted by design element in the Model Element Breakdown Structure, which is described in the next section.*

Level of Development

Element Detail Designation (EDD) indicates how closely a virtual element visually resembles its real-world counterpart, including geometric dimensional accuracies. Element detail

communicates physical dimensions of an object and graphical characteristics, such as shape, size, and location. PennDOT designations for element detail are summarized in Table 8.

Table 8. PennDOT Element Detail Designations

EDD	Definition
D-1	3D model elements represent **general** size and shape. 2D model elements shown as symbols or lines.
D-2	3D model elements represent **approximate** size and shape. 2D model elements represent **approximate** shape and length. Standard or special drawings may be needed to provide graphical details not included in the model element (e.g., reinforcing steel, bolts, connectors).
D-3	3D model elements represent **specific** size and shape. 2D model elements represent **specific** shape and length. Standard or special drawings may be needed to provide graphical details not included in the model element (e.g., reinforcing steel, bolts, connectors).
D-4	3D model element represents the **fabrication** size, shape, and graphical details. Depiction of design fabrication details are modeled in 3D to enable quantity takeoffs without the need of standard or special drawings. 2D model element represents the **fabrication** shape and length.

Element Information Designation (EID) conveys the amount of information that can be obtained directly from the model element. Information includes geometric details and non-geometrical properties also referred as property sets. Element information communicates the reliability of measurements and quantities to meet construction specifications (e.g., pay item quantities), and other information required for asset management such as material properties, warranty information and manufacturer's details. PennDOT designations for element detail are summarized in Table 9.

Table 9. PennDOT Element Information Designations

EID	Definition
I-1	Model elements are in **general** location and orientation. Location and orientation represented quantity of the element are not reliable and may not be used for construction measurements. Element contains dimensional geometric data, but does not have attributes attached; thus, information cannot be reliably derived from the model element without notes, dimensions, and special details and/or tables.
I-2	Model elements are in an **approximate** location and orientation. Although the orientation and location of the element may still change, quantities measured by "each" are reliable. All other 2D and 3D quantities are only approximate and may not be used for construction measurement or payment. Notes, dimensions, and details may be needed to obtain further element information. Information attributes may be attached as a placeholder to input detailed information later as the model element progresses in the modeling process.
I-3	Model elements represent the design intent location and orientation. All 2D elements queried for individual (e.g., each), linear and area (e.g., square yards) quantities are reliable for construction measurement and payment, Quantities for 3D elements are not reliable without the use of notes, dimensions, and details.

	Attributes containing data pertinent to construction, such as pay item number and material type (Pub 408 specifications) have been added to the model elements and the associated data may be reliably queried.
I-4	Model elements represent the design intent location and orientation. All 2D and 3D elements queried for individual (e.g., each), linear, area and volumetric (e.g., linear feet, square yards, cubic feet) quantities are reliable for construction measurement and payment. Model elements contain the same I-3 attributes needed for construction and may be used as the base for creating deliverables for digital as-built models.

Design Information Management

This section outlines the development and management of model elements, and their data, during the design process for digital delivery. The goal is to communicate the design intent of the model clearly and effectively to the contractor. The following requirements shall be used on all digital delivery projects:

Digital Delivery Requirements	Purpose
Model Element Breakdown Structure and Development Progression	Defines elements to be modeled and, to what detail and information level at each milestone submission.
Project Digital File Index	Documents the project specific digital files for each milestone submission
Quality Management Review Checklist	Documents the quality management reviews for the project
Digital Delivery Process Maps	Documents specific model use case processes that include data exchanges and decision points.
Digital Delivery Execution Plan	The documentation of the project specific digital delivery process

Templates for producing these required documents can be found on the PennDOT Digital Delivery website. The following sections describe these digital delivery methods and how they are applied on projects.

Model Element Breakdown Structure

A Model Element Breakdown Structure (MEBS) is a classified list of model elements which is used to develop an inventory of all the design objects being modeled for a project. These model development standards are the baseline for creating a repeatable process for producing consistent digital deliverables. PennDOT modeling standards will provide direction to project delivery staff, including project managers, designers, and engineers regarding the requirements for producing digital design models for construction.

The PennDOT MEBS will also communicate the progression of modeling requirements for each design element at each milestone deliverable. The engineering confidence, design detail and information of the individual model elements increase as the design progresses through the project lifecycle. The MEBS will designate a specific, minimum level of development to each

model element for each milestone. The MEBS is a blueprint for the model which will be used by the model authors to understand what to produce and to convey the limitations/authorized uses. Model users rely on the MEBS to understand what information is being received and its intended use.

Note: Appendix A of this document contain descriptions and graphics of select elements for each discipline. This appendix is intended to give the modeler and reviewer a good understanding of how much detail and information each element should contains at each deliverable milestone.

PENNDOT MODEL BREAKDOWN STRUCTURE CATEGORIES

The list of model element categories is organized by groups of components typically modeled either in 2D or 3D. It is important to understand that a model element is not a pay item, but rather a virtual object or feature that represents the physical asset to be constructed. For example, the contractor builds a pavement structure that is made of multiple layers; the pavement structure is typically modeled using layer components, such as wearing course, base subbase, etc. and those components are used to derive quantities that are associated with a specific pay item based on the type of material, mix design, thickness, etc. However, the pay item associated with “flexible pavement evaluation” is not something that is ever modeled, thus it is not listed in the model element breakdown structure. Pay items not associated with model objects will still need to be included in the schedule of bid items.

MODEL ELEMENT BREAKDOWN STRUCTURE WORKBOOK

The MEBS workbook is a companion to the interim guidelines, which is a tool created to accomplish the following objectives:

- Document the specific elements to be modeled for a project
- Provide a consistent and standard process to determine the minimum level of information and detail associated to an element at each milestone submission

The MEBS workbook lists the standards for each model element broken down into a series of discipline worksheets. The workbook is to be used by the design team to identify the design elements to be included in the model deliverable and to determine the expectations for minimum EDD and EID that each modeled element must possess at the time of the indicated submittal.

The disciplines within the PennDOT MEBS workbook include:

Geometry	Roadway	Earthwork
Drainage	Structures	Utilities
Traffic	ESPC & PCSM	Rail
Right-of Way	Existing Survey	Landscaping

Each discipline has a workbook tab that is to be completed by the corresponding discipline engineer or designer and delivered with the DDEP prior to the start of the project. The tab is broken out by model element, submittal phase, and reviewer.

MEBS Workbook Guidance

The MEBS workbook is to be used as a planning device to direct the modelers during each phase of a project. A new MEBS workbook should be used when starting a new project. The workbook is pre-set to the minimum required level of detail and information for each element.

The MEBS workbook contains 13 worksheets. The first sheet contains instructions on the use of the workbook and the second is where you can fill in your project information. This information is linked to the header of the other 11 discipline specific worksheets. Refer to the Instructions and Definitions worksheet for the proper way to fill out each worksheet.

Below are the high-level steps to complete the MEBS workbook. Refer to the Instructions and Definitions tab for detailed steps to fill out each worksheet.

- Download or copy the MEBS workbook template to your project data location and rename appropriately following the PennDOT file naming convention. This can be found in the Model Standards Manual.
- Fill out the project information in the section tab.
- Review the discipline tabs to identify which elements will be in your project.
- Hide any discipline tabs that are not within the project. Right click on the tab and select “Hide”. To unhide a tab go to Home >> Cells >> Format >> Unhide Sheets.
- In the remaining discipline tabs work with the project team to identify if each element is in the project or not.
    - If it is not known yet if a particular element is in the project, the project team should set the element to Yes for In Project and then No for the specific In Submittal.
    - If the minimum detail, minimum information, or 2D/3D standard needs to be increased for a particular milestone, change the specific cell, and document the change in the “Comments” cell.
    - If there are numerous elements that are not in a project, the user can select “No” for “In Project” and drag the cell down through the appropriate rows.

Project Digital File Index Workbook

The purpose of the Project Digital File Index is to document every digital file submitted at a milestone submission. This is similar to the plan set Title Sheet with the list of plan sets included in the project. The index is developed at the beginning of the project and updated for each submission. The index contains the project information with current submittal, discipline, file name, file description, responsible party. Figure 9 is an example of a project digital file index.

Figure 9. Example of Project Digital File Index

Project Digital File Index

Project Name:	SR 3031 Realignment
County Number:	63
State Route or Township Number:	3031
Section Number or Survey callout:	650
ECMS Number:	123456
Current Submittal:	Design Field View

Discipline	File Name	Description	Responsible Party
Drainage	633031650_DRA01.dgn	Drainge system	Eva Guzman
Earthwork	633031650_PROS.dgb	Proposed complex surface container file	Eva Guzman
Exports	633031650_BREAK.xml	Proposed breaklines LandXML file	Eva Guzman
Exports	633031650_PROS.xml	Proposed surface Landxml file	Eva Guzman
Geometry	633031650_ALG01.dgn	SR 3031 Alignment	Darrin West
Geometry	633031650_ALG02.dgn	Side road alignments	Darrin West
Geometry	633031650_ALG03.dgn	Driveway alignments	Darrin West
Roadway	633031650_PLAN.dgn	Planametrics file	Eva Guzman
Roadway	633031650_COR1.dgn	SR 3031 Corridor	Eva Guzman
Roadway	633031650_COR2.dgn	Side road and driveway corridors	Eva Guzman
Structures	633031650_STR1.dgn	ST 3031 Bridge	Christopher Austin
Survey	633031650_SURV1.dgn	Existing survey	Darrin West

The discipline column identifies the type of file, such as geometry, roadway, structures, drainage, sheets, models, exports, and are assigned using a pulldown menu within the spreadsheet. Additional disciplines can be added to the excel file following the instructions tab. Each file name follows the appropriate naming convention and file extension (e.g., dgn, .xml). The file naming convention is outlined in the Model Standards Manual. A brief description can be added for each file. Container files should also be noted in the description. The responsible party is typically the model author or the person who is in charge of making changes to the design file. Project teams can create a pdf of the index at each file submission for document control purposes.

Quality Management Digital Review Checklist Workbook

The purpose of the Quality Management Digital Review checklist workbook is to provide a series of checklists for each type of quality management review. This workbook will help designers and engineers prepare and document consistent model-based reviews at each milestone submission. The workbook defines the criteria for a technical reviewer to conduct model-based design reviews for complete and accurate submittals. The goal of the checklist is to obtain concurrence and approval of the model deliverable at each milestone submission. The senior project manager assigns persons responsible for the reviews and verification of check-off for each review type.

Prior to conducting quality management digital reviews there are three required documents that need to be provided to the reviewers. The prerequisites documents are:

- Digital Delivery Execution Plan
- Model Element Breakdown Structure Workbook
- Project Digital File Index

See **Chapter 6: Quality Management** for detailed information on quality management digital reviews.

Digital Delivery Process Maps

A process map is a visual map representing a workflow consisting of sequencing and interaction between activities and identified information exchanges. Process maps provide an understanding how data, processes and actors or individuals interact throughout the workflow. Developing process maps allows for a better understanding of each process and how that process will be used on a project. There are many types of process maps such as flow charts, high level process maps, or detailed process maps.

Process Maps

Process maps include three sections of information that are listed on the left side of the map that are referred to as a swim lane. The sections include reference information, process, and information exchange. (Figure 10)

Figure 10. Blank Process Map Outline

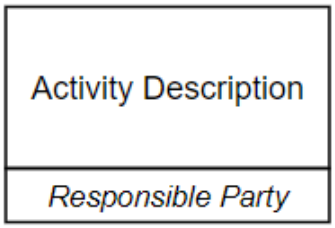
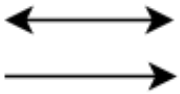
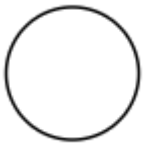
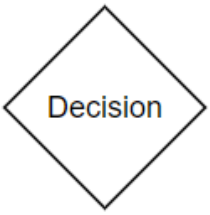
The reference information is structured information that is necessary to complete the use case. An example of reference information would be geotechnical boring logs. The process section is the sequence of events that take place within the use case. Each rectangle includes a

responsible party for the task. While there may be multiple responsible parties, it is imperative to identify a single responsible party for each task. The information exchanges section includes the deliverables from one process to another. An example of an information exchange would be a discipline model.

Process Map Symbols

Table 10 provides common symbols used in a process map.

Table 10. Process Map Symbols

Symbol	Notation
	Represents a specific process and its activities. May include responsible parties
	Represents the direction of information flow and connection between steps
	Represents the beginning or end points of a process
	Indicates a decision point. The process follows a predefined path depending on the decision.

Process Maps by Model Use Case

An overall process map includes critical information exchanges and interactions between digital delivery use cases on a traditional design project. Additional information on how to edit or create a project specific process map can be found in **Chapter 8: Project Digital Delivery Requirements**.

Individual detailed process maps have also been developed outlining the use case sequence of activites. The detailed PennDOT example process maps in **Appendix B: PennDOT Example Process Maps** include:

- Existing Conditions Modeling
- Design Authoring
- Visualization
- Design Review
- 3D Coordination and Clash Detection
- Design Quantities
- Temporary Construction Model (To be developed)
- Digital Delivery Contract Documents (To be developed)
- Construction Inspection, Verification and Acceptance (To be developed)
- Construction Planning (To be developed)
- Construction Layout (To be developed)
- Shop Model Authoring (To be developed)
- Digital As-built (Record Model) (To be developed)

Digital Delivery Execution Plan

Using digital delivery to develop contract documents requires various stakeholders to have the ability to produce, share, and consume digital information. Recipients of digital deliverables need consistency in the formatting and structure to create a predictable and repeatable process for interacting with the digital content. Digital design models may also be created to multiple degrees of detail and accuracy to meet specific objectives. A DDEP is a comprehensive document that is utilized throughout the project lifecycle to help the project team develop and execute workflows to deliver projects with digital requirements.

The DDEP is used to define the goals of the intended uses of the 3D models, which allows the project team to document what information is needed and the most efficient way to provide to specific model users. The DDEP also documents project specific modeling processes, model progression documentation, digital deliverables, and review protocols.

See **Chapter 8: Digital Delivery Execution Plan Guidance** for detailed information on developing a Digital Delivery Execution Plan for the project.

Chapter 4: Design Milestone Modeling Requirements

This chapter covers the minimum modeling requirements for each milestone deliverable of a digital delivery project. Using the Modeling Development Concepts in **Chapter 3: Model Development Concepts**, the following sections outline the modeling criteria and required information for modeled elements, in addition to PennDOT project milestone submission standard requirements. The following standards are contractual requirements for digital deliverables.

Milestone Submissions

The modeling requirements described in this chapter apply to PennDOT's standard project milestone submissions:

- Line, Grade, and Typical Section
- Safety Review
- Design Field View
- Final Design Office Meeting or Constructability Review
- Plans, Specifications and Estimate
- Digital As-Builts Submission

Other design submissions, such as right-of-way, permit, utility, and traffic control, will have their own digital delivery requirements. These requirements are currently being- developed with external stakeholder coordination. For pilot project submissions, project teams can coordinate with the Digital Delivery Team.

Planning

At this early stage of a project a rapid visualization 3D model may be developed using tools like Bentley ConceptStation to represent schematic designs in planning work. **There are no engineering details incorporated into this model.** The purpose of this model is to assess and communicate conceptual designs being proposed within the context of its surroundings. These models are strictly for visualization of concepts. A standard geographic coordinate system has been set for purpose of GIS coordination.

Line, Grade and Typical Section

The purpose of this model is to support the required functions of the Line, Grade, and Typical Section submittal, which is to effectively establish the horizontal footprint of the project after the preferred alternative has been selected and approved for design.

Each of the model elements is designed to comply with the Model Element Breakdown structure for Line, Grade and Typical Section. See **Appendix A: Model Element Progression for Design** for a detailed breakdown of modeling criteria for each element.

Line, Grade and Typical Section Deliverables

The following model-based deliverables will be included with the Line, Grade, and Typical Section deliverables.

- Single Project PDF displaying plan and profile views
- Model Design Review session with federated 3D model
- Review meeting to walk through the federated 3D model

Safety Review

The purpose of this model is to perform a safety review and prepare a Safety Review Report, which requires the corridor models to be updated to reflect barrier warrant design and clear zone summaries. Corridor models at this point include roadway elements that allow for the determination of sight distance requirements and clear zones for barrier designs. Each of the model elements should comply with the MEBS workbook.

Safety Review Deliverables

The following model-based deliverables will be included with the Safety Review deliverables.

- Single Project PDF displaying plan and profile views
- Model Design Review session with federated 3D model
- Review meeting to walk through the federated 3D model

Design Field View

The purpose of this model is to identify critical design issues and/or conflicts to be discussed and resolved; depict environmental mitigation strategies and assess impacts to adjoining property. Each of the model elements should be designed to comply with the MEBS workbook.

Design Field View Model Based Deliverables

The following model-based deliverables will be included with the Design Field View deliverables as described in Publication 10C.

- Single Project PDF displaying plan and profile views
- Model Design Review session with federated 3D model
- Review meeting to walk through the federated 3D model

Final Design Office Meeting or Constructability Review

The purpose of this model is to assess constructability and identify any updates to the design prior to finalizing quantities, including updates to the original existing conditions model. In this model:

- Original ground survey has been verified and/or updated to account for any changes needed to manage uncertainty and risk.

- Design Field View model has been updated to reflect final design intent.

Each of the model elements is designed to comply with the MBES workbook.

Final Design Office Meeting or Constructability Review Model Based Deliverables

The following model-based deliverables will be included with the Final Design Office Meeting or Constructability deliverables as described in Publication 10C.

- Single Project PDF displaying plan and profile views
- Model Design Review session with federated 3D model
- Review meeting to walk through the federated 3D model

Plans, Specifications and Estimate

The purpose of this model is to provide a final bid model package for Bidding and Letting. Each of the model elements shall comply with the MEBS workbook.

Plans, Specifications and Estimate Model Based Deliverables

Refer to the section on Digital Delivery Contract Documents of **Chapter 7** for the Digital Bid Model Package requirements.

Digital As-Built or Construction Record Model

While the PennDOT specific requirements for delivering a digital as-built model have yet to be determined, it will be based on the contractual PS&E model, and it may contain multiple types of updates such as:

- Model elements constructed outside of tolerance shall be updated to reflect actual as constructed field locations and details, including final quantities.
- Geometric dimensions have been field verified and accepted by the Engineer.
- Major transportation asset class attributes are linked to the modeled element per the owner’s information requirements.

This section is still being developed.

Chapter 5: Bridges and Structures Milestone Modeling Requirements

This chapter covers the modeling requirements of bridge milestones for digital delivery projects. Using the Modeling Development Concepts in **Chapter 3: Model Development Concepts**, the following sections outline the modeling criteria and required information for modeled elements in addition to PennDOT project milestone submission standard requirements. **Appendix A: Model Element Progression for Design** describes the modeling criteria and required detail and information for modeled elements at milestone submissions. This chapter covers the minimum modeling requirements for each milestone deliverable of a bridge project. The following standards are contractual requirements for digital deliverables.

Milestone Submissions

The modeling requirements described in this chapter apply to PennDOT's standard project milestone submissions:

- H&H Report
- Type, Size, and Location
- Foundation Report
- Final Review of Plans
- PS&E
- Digital As-Builts Submission

Hydrology and Hydraulics Report

The purpose of this model is to supplement the H&H report requirements outlined in DM-4 PP 1.9.2. This model submission is only required for bridges over waterways. Bridge models will need to have elements to the required detail and information level in the MEBS in order to sufficiently apply for permits including:

- Bridge total length, span length and width
- Low-chord elevation
- Hydraulic opening dimensions
- Encroachments in streams including piers and any elements which could be overtopped in flood events.

H&H Report Deliverables

The following model-based deliverables will be included with the H&H Report deliverables as described in DM-4 PP 1.9.2.

- Model Design Review session with project 3D model
- Review meeting to walk through the 3D model
- Bridge plan, elevation and typical section views generated from model

Type, Size, and Location

The purpose of this model is to investigate, select and justify the type, size, and location of the proposed structure. The model shall supplement the TS&L letter content with the information outlined in DM-4 1.9.3.3.1(b). Only the model for the proposed alternative will be required; however it may be beneficial to use multiple models for cost and other comparative analysis. A streamlined TS&L does not change the requirements of the TS&L model. Each of the bridge model elements must comply with the MEBS workbook.

Type, Size, and Location Deliverables

The following model-based deliverables will be included with the Type, Size, and Location deliverables as described in DM-4 PP 1.9.2.

- Model Design Review session with project 3D model
- Review meeting to walk through the 3D model
- Bridge plan, elevation and typical section views generated from model

Foundation Report

The purpose of this model is to investigate, select, and justify the proposed foundation of the structure. In general, the model shall supplement the TS&L letter content with the information outlined in DM-4 1.9.4.3.1(b). Each of the model elements must comply with the MEBS workbook.

Soil profiles shall be included in 3D and referenced with the structure model. 2D boring logs may also be included within the foundation report. A streamlined Foundation submission does not change the requirements of the Foundation Report model.

Foundation Report Deliverables

The following model-based deliverables will be included with the Foundation Report deliverables as described in DM-4 PP 1.9.2.

- Model Design Review session with project 3D model
- Review meeting to walk through the 3D model
- Bridge plan, elevation and typical section views generated from model
- Existing foundations of conflicting or adjacent structures included in project 3D model
- Foundation specific notes as outlined in DM-4 PPP 1.0.4.3.1(b)(13)

Final Review of Plans

The purpose of this model is to provide final design deliverables for review and approval of the structure. In general, the model shall provide the applicable items on the checklist of minimum items outlined in DM-4 1.9.5.3. Each of the model elements must comply with the MEBS workbook.

Final Review of Plans Deliverables

The following model-based deliverables will be included with the Final Review of Plans deliverable as described in DM-4 PP 1.9.2.

- Model Design Review session with federated 3D model (in vicinity of bridges)
    - Review meeting to walk through the 3D bridge model.

Plans, Specifications and Estimate

The purpose of this model is to provide a final bid model package for Bidding and Letting. Each of the model elements shall comply with the MEBS workbook.

Plans, Specifications and Estimate Model Based Deliverables

Refer to section on Digital Delivery Contract Documents in **Chapter 7** for the Digital Bid Model Package requirements.

Digital As Built or Construction Record Model for Bridges and Structures

While the PennDOT specific requirements for delivering a digital as-built model is yet to be determined, it will be based on the contractual PS&E model, and it may contain multiple types of updates:

- Model elements that were constructed outside of the construction tolerance have been updated to reflect actual as constructed field locations and details, including final quantities.
- Geometric dimensions have been field verified and accepted by the Engineer.
- Major transportation asset class attributes are linked to the modeled element per the owner’s information requirements.

This section is still being developed.

Chapter 6: Quality Management

This chapter provides guidance on quality management procedures for digital reviews and describes the roles and responsibilities for each type of reviewer. Reviews of digital deliverables are to be conducted throughout the design process and documented accordingly in the DDEP.

Quality management is the act of overseeing activities and tasks that must be accomplished to maintain a desired level of excellence. The guidance in this chapter provides the process by which digital deliverables are checked against the contract requirements and standards. Reviews of digital deliverables can be conducted often (weekly or monthly) or prior to project milestones. The responsible parties for these different reviews throughout the project lifecycle, will provide project teams with the necessary quality assurances needed. The following sections provide guidance on the different types of digital reviews.:

Quality Management Digital Reviews

Quality management digital reviews fall into the following four categories:

- Design Compliance Reviews
- Model Integrity Reviews
- External Stakeholder Review
- Deliverables Review

Each of the four categories are further sub-categorized in Table 11 by type of review. Responsible parties have been added to help designate individuals for each of these reviews.

Table 11. Types of Quality Management Model Reviews

Review Category	Review Type	Description	Responsible party
Design Compliance Reviews	Design Criteria	Review the model for compliance with design manuals and standards such as AASHTO, FHWA, PennDOT Pubs. Also review design calculations and the application of this data within the models. (e.g. superelevation, beam, and girder design).	Senior Project Manager, Design Squad Project Manager
	Constructability	Review the model for constructability or staging issues.	Design Squad Project Manager
	Interdisciplinary	Review the model in a federated state with other disciplines to identify any conflicts (hard or soft clashes) or issues that may exist between design elements or between existing and design elements.	Design Squad Project Manager, Project Model Manager
Model Integrity Reviews	Geometric Integrity	Review the models for correct usage of modeling elements such as appropriate 2D and 3D objects, duplicates and omissions of components, geospatial attributes.	Project and Design Squad Model Manager
	Model Development Standards	Review the model fidelity versus the MEBS that was developed for the project.	Project and Design Squad Model Manager
	Modeling Standards	Review the model for correct application of modeling standards such as naming conventions, feature definitions, pay items.	Project and Design Squad Model Manager
External Stakeholders	External Stakeholders	Reviewing the model with regards to external stakeholder applications such as permits, utility relocation, and right of way.	Senior Project Manager, Project Model Manager
Deliverables	Deliverable Reviews	Review the digital deliverable submission package for compliance with the PennDOT Digital Delivery Interim Guidelines.	Senior Project Manager, Project Model Manager

Design Compliance Reviews

Design compliance reviews are broken into 3 types: design criteria, constructability, and interdisciplinary.

DESIGN CRITERIA

The purpose of the design criteria review is to check that the project design models conform to design and project criteria, comply with Department Standards, and accurately portray project specific calculations. This means the reviewer is determining if the correct design criteria has been outlined for the project and if that criteria is being implemented. This review is typically coordinated by the senior project manager prior to each milestone submittal and is conducted in accordance with the quality management procedures for the project.

This review includes checking that the design models meet the design criteria for the project such as AASHTO Green Book, AASHTO LRFD Bridge Design Specifications, or PennDOT publications. For example, alignments and profiles should be reviewed for the application of proper geometry for design speeds and sight distances.

Design calculations are also reviewed against the model, including but not limited to:

- Geometry (i.e., superelevation, sight distance, minimum clearance),
- Project type design criteria (i.e., 3R, betterment, new replacement)
- ADA requirements,
- Barrier warrants,
- Traffic signal warrants,
- Lighting analysis and calculations,
- Utility relocation plans,
- Pavement design,
- Geotechnical reports and remediation designs,
- Drainage reports
- Hydraulic analysis reports (pipe and structure sizes, compensatory and detention storage needs, pavement overtopping, scour, etc.),
- Structural calculations (i.e. beam selection, reinforcement clearances, retaining wall tie backs, shaft/pile depths, etc.).

The review can be conducted in the design authoring software or design review software prior to each milestone submission and rechecked if the design changes.

CONSTRUCTABILITY REVIEW

The Constructability review is conducted to identify issues with regards to constructability or staging. This review may take place weekly with the design squad or team on large complex projects, or monthly on non-complex projects. The design squad project manager is responsible for the review. Experts with construction management experience can also be part of this review. A constructability review can be executed in the design authoring or design review software.

INTERDISCIPLINARY REVIEW

The interdisciplinary review is conducted to check the interaction between discipline model files for clashes and conflicts, clearance tolerances, and spatial coordination of elements. This review involves identifying hard and soft clashes between elements. This can be done through visual inspection of the models or through software applications that can run clash detection based on specified parameters. Hard clashes are clashes that are the result of two objects or elements intersecting each other or taking up the same geographical space. When an element or object is not given a spatial or geometric tolerance or its buffer zone is crossed, the result is a soft clash. Based on the results of the spatial coordination, design teams can implement measures to address these clashes.

This review is typically coordinated by the design squad project manager or discipline lead prior to each milestone submittal and can be conducted in the design authoring software or the design review software. It is important to recognize that model authors must be continuously performing interdisciplinary checks against other discipline models during the design development.

Model Integrity Reviews

Model integrity reviews are broken into three types: geometric integrity, model development standards, and modeling standards.

GEOMETRIC INTEGRITY

Geoemtryic integrity determines if the model elements have been developed following the design criteria and are in the correct position in space. A geometric integrity review is conducted to check the integrity of the design models against the design typical section details. This verifies that the models match the design details for elements within the typical section, such as pavement depths, curb & gutter, barriers, grading, and roadside drainage. Models are reviewed for proper transition between elements, such as slope grading and superelevation cross slopes. A review of the models for right of way and limits of development impacts are also conducted. The integrity of each design model is checked for errors such as duplicate elements, element deformities, or incomplete elements or segments.

Geometry reviews can be conducted in the design authoring software by the discipline leads, the project model manager and project manager.

MODEL DEVELOPMENT STANDARDS REVIEW

The Model Development Standards review is conducted to check that the project models are in conformance to the model development standards which are outlined in the MEBS. The MEBS should be used to check that existing and proposed model elements are developed to the correct level of detail and information for each submission milestone. This review is conducted prior to each milestone submittal and primarily executed in the design authoring software by the design squad project manager or project model managers.

MODELING STANDARDS REVIEW

Conformance to the PennDOT modeling standards includes reviewing the models and design files for compliance to the model file naming convention for individual files and container files,

element templates, template design conventions, file seeds, coordinate systems and file folder structure and architecture. Model elements are reviewed for the correct feature definitions, styles, material types and data attributions such as pay item and asset management information. The project model manager is responsible for this review and will typically use the design authoring software.

External Stakeholder Review

External stakeholder reviews include reviewing model-based deliverables for permits, utility relocations or right of way submissions. While some external stakeholder submissions may still be 2D pdf submissions, the data used to develop the documents will be digital. The process to conduct these types of reviews, along with using 3D models with external stakeholders, is currently under development. The senior project manager or project model manager are responsible for these reviews, which can be conducted in the design authoring or design review software.

Deliverable Review

The deliverable review verifies that the digital delivery package includes all models, plans and design documentation required for each milestone submission as well as confirming that the digital files have been checked for consistency and completion. The senior project manager is responsible for this review, which are conducted prior to each milestone submission.

Quality Management Review Checklist

A quality management review checklist has been developed with individual worksheets for the different reviews. The workbook has been developed to provide documentation for reviewers at each milestone and each type of review. The checklist is a living document and will be updated by multiple reviewers. The checklist can be downloaded through the PennDOT Digital Delivery website and is to be appended to the project DDEP.

Chapter 7: Model Use Case Guidance

This chapter provides further information and processes on different model use cases. The current list of use case guidance and the current state of development is listed below. Additional use cases may be added throughout the development of the interim guidelines

- Milestone Design Reviews and Deliverables
- Digital Delivery Contract Documents
- Contract Management Processes
- 3D Coordination and Clash Detection (In development)
- Design Quantities (In development)
- Visualization (In development)
- Digital As-Builts Information Requirements (In development)

Milestone Design Reviews and Deliverables

At each milestone or model review, there are multiple files and documents that must be compiled for the review teams. This use case section outlines the required milestone digital documents and outlines the processes to prepare the digital model files for review. This section provides guidance on milestone submissions for digital delivery, which are composed of documents and digital model files. The exchange file format requirements are also included herein.

Milestone Digital Documents

Table 12 contains the digital documents that must be submitted at each milestone review. After each milestone review, any comment resolution files should be documented with the project team.

Table 12. Digital Document Submissions

Deliverable	File Format	Notes
Digital Delivery Execution Plan	PDF	Contains all appendices including custom process maps
Model Element Breakdown Structure	Excel File + PDF	The pdf can be used by reviewers to markup and comment
Project Model File Index	PDF	Contains all model files being reviewed

Preparing and Publishing Digital Submission

Digital deliverables are created in different software packages. PennDOT is developing a process for digital design file submissions for advertising. The process will be documented in **Appendix C: Preparing and Publishing Digital Deliverables** to identify the deliverables at each milestone submission.

Model File Preparation for Review

Reviewers who do not have experience with or access to native design software will review and comment on the project model in Bentley System's ProjectWise 365 web-based application. It will be the responsibility of the Model Manager to prepare the project models for their use in this online application. The following steps outline the process of preparing the various discipline models.

Review Model Container

Begin with an empty PennDOT 2D seed file that has been designated for your project.

This file will serve as container that will house the necessary project model files to be reviewed. This fill will need to be activated as a Civil Model just as you would to begin an ORD design. The process to assemble and activate the container file is from a post on Bentley Communities:

1. Create a 2D container file with *OpenRoads Designer*.
2. This container file needs to be created from the correct seed file in the Workspace used by the dataset.
3. The container file needs to have the correct Geographic Coordinate System (GCS) for your project.
4. Attach all needed/required civil (ORD/OBM) reference files. (Figure 11)
5. Attach the Default (2D) model of each civil file to the Default (2D) model of the container file.
6. Attach the terrain Default (3D) to the Default 2D model of the container file.

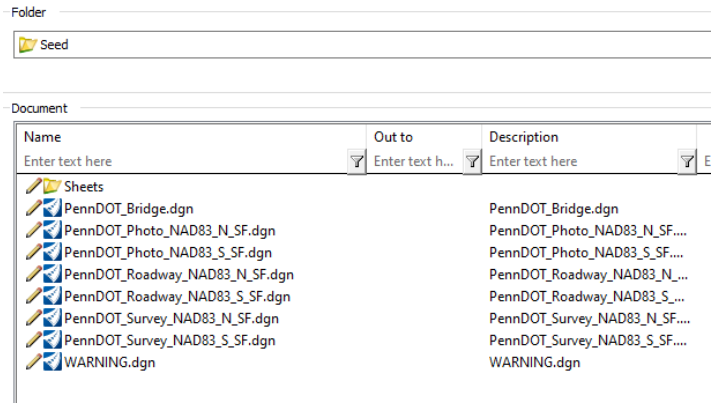


Figure 11. PennDOT Seeds

7. To activate the Civil Model in the container file simply select the attached terrain and make it active. This will create the 3D-Default model in the container file and subsequently import all of the attached civil file's 3D-Default models
8. Review the hierarchy of the reference files. Be sure that ALL required files/models are listed.
9. Ensure the Reference Display = ON for each reference attachment you want to show in the iModel.
10. While in the Default (2D) model of the container file set its attached 3D-Default model to a minimum nesting depth of 1.

For a video and further information: (Best Practices for Creating a Civil Model)

ProjectWise 365 Session

A ProjectWise 365 session must be created and configured to allow for the connection of the review model container. Pilot projects should contact the resource account (RA-PDDigitalDelivery@pa.gov) for your session setup.

Once the ProjectWise 365 session has been created, reviewers can be invited into the session and appropriate training is available.

Design Review Quality Management

Following the completion of the milestone design review sessions, documentation should be produced including comments and revisions for quality management purposes. Refer to **Chapter 6** for detailed quality management processes. Documentation includes:

- Issue and comment resolution report
- Design reports, such as horizontal and vertical alignment reports
- Quantity reports
- Milestone completed checklists

Digital Delivery Contract Documents

Digital delivery projects will have specific contract documents that will be included in the bid package and submitted through ECMS. Additional submissions, documents, and PennDOT PS&E procedures should still be followed.

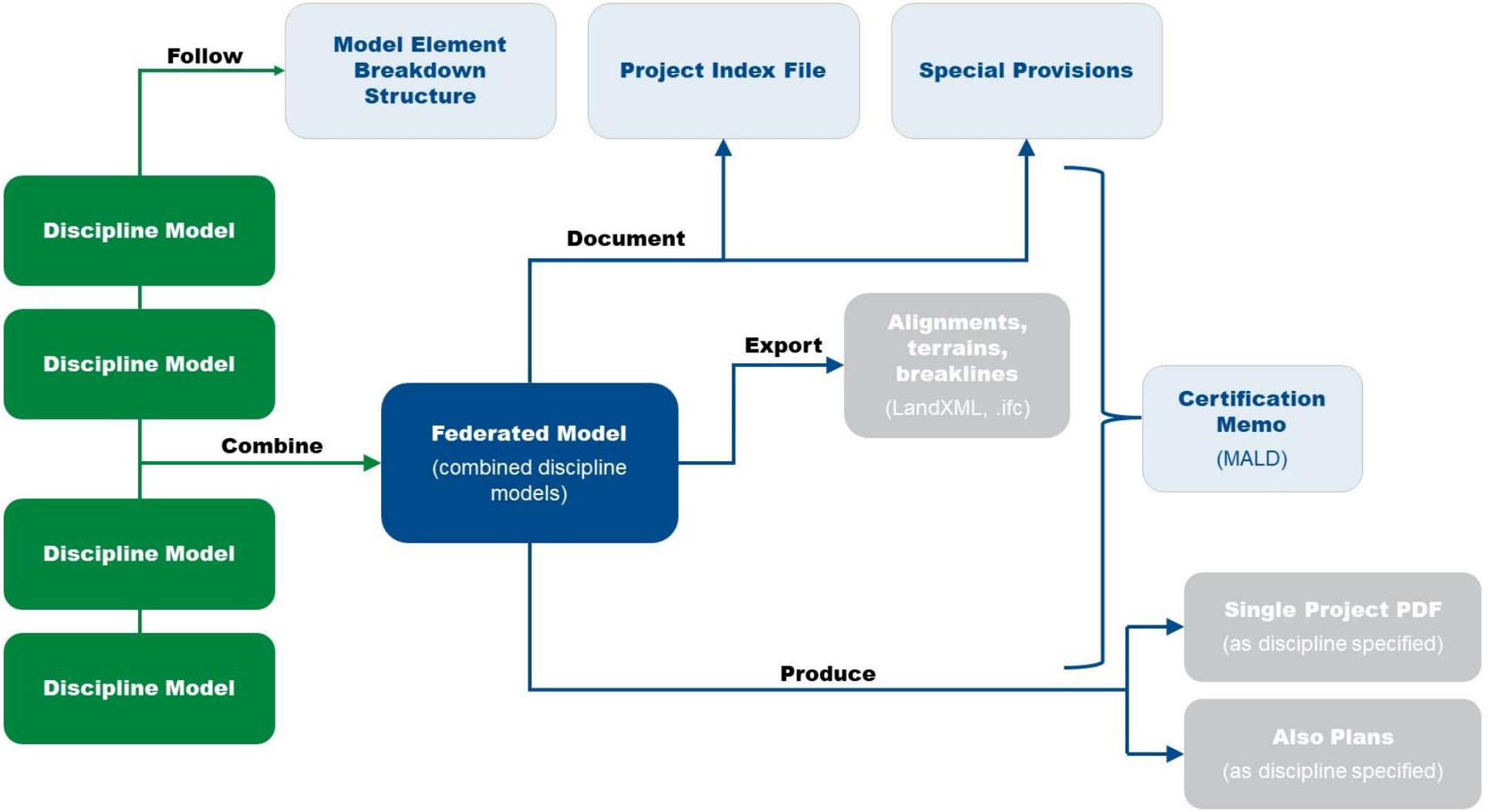
PS&E Deliverables

Table 13 includes the document deliverables that are to be compiled and submitted with the digital model files. The Project Manager should contact the Digital Delivery Section lead for more information about the certification memo process and the inclusion of specific special provisions. Figure 12 provides an overview of the PS&E digital deliverable submission package.

Table 13. PS&E Digital Documents

Deliverable	File Format	Notes
Certification Memo	PDF	The memo documents the signing and sealing of digital files and outlines which files are legal documents and for information only.
Special Provisions	PDF	Specific digital delivery special provisions.
Model Element Breakdown Structure	PDF	Excel file can be submitted instead but should be locked for editing.
Project Model File Index	PDF	Provides descriptions of the contents of each model file delivered in the PS&E package.

Figure 12. PS&E Deliverables



Digital Model Submissions

The Project Manager should work with the Digital Delivery Section Lead to verify which file formats will be delivered as either Legal Documents or For Information Only. The digital bid model package will be signed and sealed in the Certification Memo and documented in the Project Index File. Table 14 provides a summary of the current PS&E digital bid model package with the appropriate file type and exchange file format.

Table 14. PS&E Digital Bid Model Package File Type

File Content[1]	File Format[2]	File Type[3]
Existing combined ground terrain	DGN	Legal document
Existing combined ground terrain export	LandXML	For information only
Alignments	DGN	Legal document
Alignments exports	LandXML	For information only
Proposed combined design and existing surfaces	DGN	Legal document
Proposed combined design and existing surface exports	LandXML	For information only
Proposed breaklines	LandXML	For information only
Federated design model files	DGN	Legal Document
Design models and corridors	DGN	Legal Document
Bridge models	DGN	Legal document
Reinforcing steel files	DGN	Legal document
Drainage models	DGN	Legal document
Drainage model exports	LandXML	For information only
Project PDF (digital roll plot)	PDF	Legal document
Right of Way files	DGN	For information only
Utility files	DGN	For information only
Traffic Control files	DGN	For information only

[1] File content describes the main elements included in the required file deliverable. Specific content requirements to be defined in ORD training material and detailed digital delivery execution plan.
[2] File format indicates the software file exchange, such as DGN, LandXML, etc.
[3] The file type indicates whether the file is considered a legal document or is provided for information only.

Contract Management Processes

The contract management process use case refers to changes to the design intent and design models through the advertisement and construction phases. The following sections provide guidance on delivering updated digital files and the appropriate documentation.

Addendum Process

During advertisement, the design model package is currently provided through ECMS to potential bidders. Questions are submitted by potential bidders through ECMS and provided to the project team.

Figure 13 outlines the typical addendum process for model changes. If a submitted question changes the design intent of the design and digital model, the project team will update the appropriate digital files. These files will be named with the original file name and appended with _ADDXX. The XX refers to the assigned addendum number. For example, if the original alignment file (633031650_ALG01.dgn) is updated, the addendum file name would be 633031650_ALG01_ADD01.dgn. Container files should also be updated with the new reference file attached, renamed, and resubmitted in the addendum package.

With the addition of the updated design files, the project file index document should be updated with the new file names. The original file rows should not be deleted, but instead use the strikethrough effect. A new certification memo will also be created based on the original memo. The updated design files will be added to the certification memo and the original files should use the strikethrough effect in the list. The memo will be resealed and submitted with the addendum package through ECMS.

RFI Process

During construction, the contractor and inspectors will utilize the design model package in the field. Issues and RFIs are submitted through PPCC and provided to the project team.

Figure 14 outlines the typical RFI process for model changes. If an RFI changes the design intent of the design and digital model, the project team will update the appropriate digital files. These files will be named with the original file name and appended with _RFIXX. The XX refers to the assigned addendum number. For example, if the original alignment file (633031650_ALG01.dgn) is updated, the addendum file name would be 633031650_ALG01_RFI01.dgn. Container files should also be updated with the new reference file attached, renamed, and resubmitted in the RFI package.

With the addition of the updated design files, the project file index document should be updated with the new file names. The original file rows should not be deleted, but instead use the strikethrough effect. A new certification memo will also be created based on the original memo. The updated design files will be added to the certification memo and the original files should use the strikethrough effect in the list. The memo will be resealed and submitted with the addendum package through PPCC.

Figure 13. Addendum Process

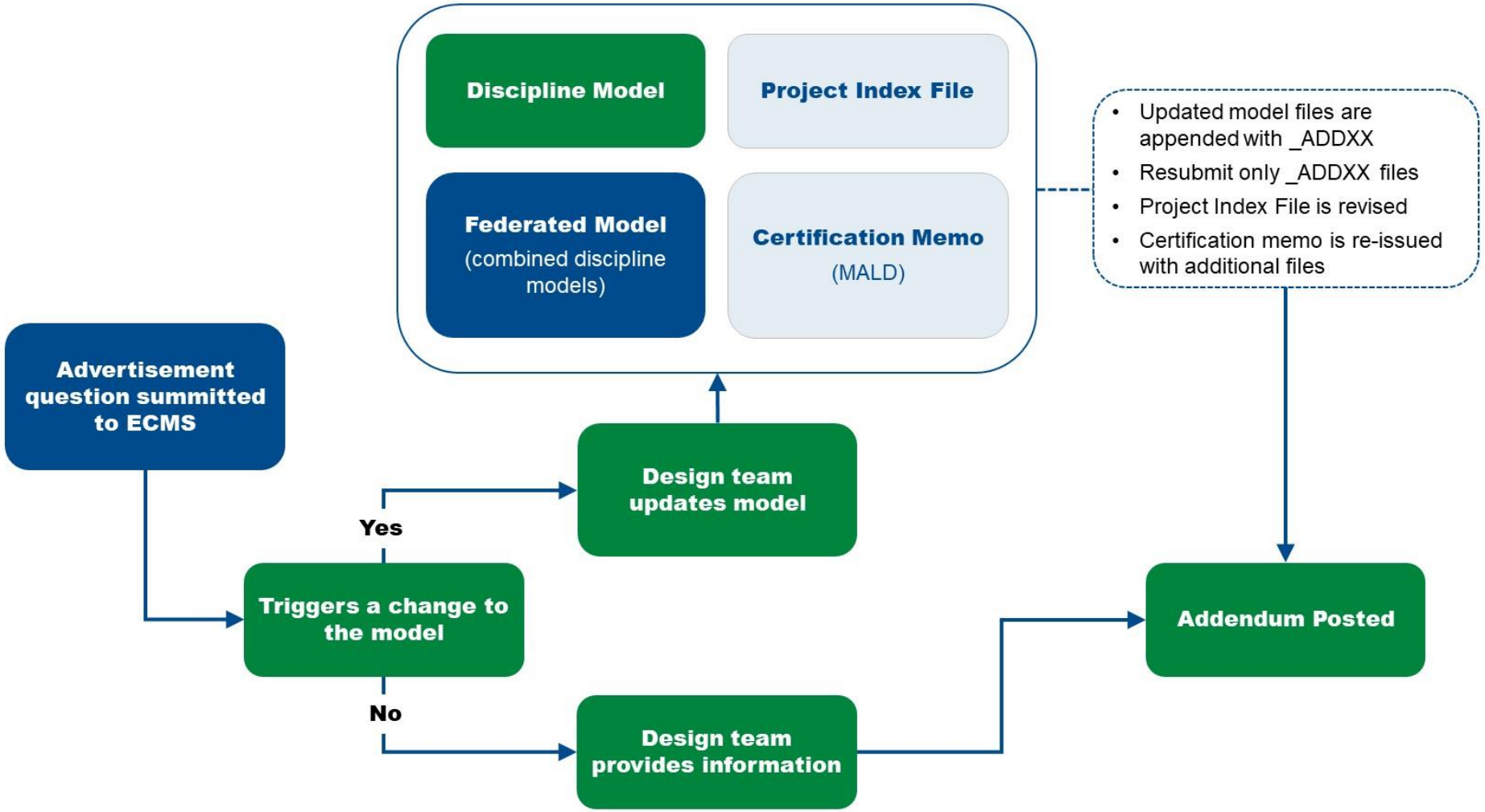
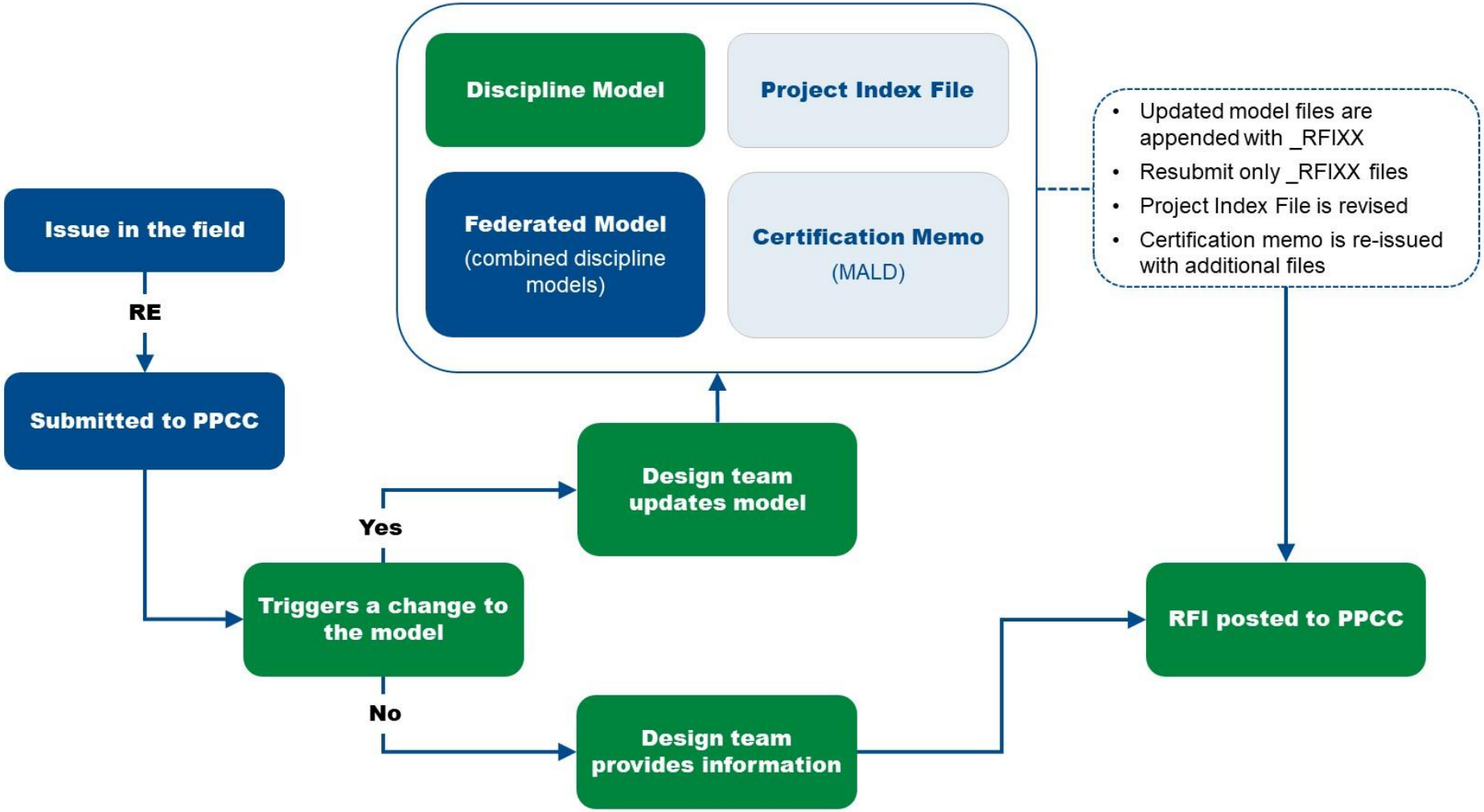


Figure 14. RFI Process



3D Coordination and Clash Detection

This section will be expanded at a future date.

Design Quantities

This section will be expanded at a future date.

Visualization

This section will be expanded at a future date.

Digital As-builts Information Requirements

This section will be expanded at a future date.

Chapter 8: Digital Delivery Execution Plan Guidance

The purpose of a Digital Delivery Execution Plan is to describe the effort necessary to create and deliver discipline specific design models, including model development requirements and how the data will be exchanged throughout the life of the project for the intended model uses. This plan is a living document that is initiated during the scoping phase and is to be utilized as reference by the staff during all phases of the design. The DDEP is to be updated as necessary throughout the design life of the project.

The Project manager and Digital Delivery Section Lead should initiate the DDEP during the scoping process for the purpose of developing the project's discipline model deliverables and creating the project contract requirements. This document is designed to help district staff with scoping projects, and to facilitate discussion with design teams regarding modeling requirements.

The project team is required to utilize the DDEP template and add detailed project descriptions to communicate how the project requirements will be met and what processes will be in place to provide a quality product. A detailed DDEP is required within 30 calendar days after project notice to proceed (NTP).

The development of the DDEP is a collaborative process. While specific portions of the plan do not require collaboration, it is imperative that the entire project team is on the same page. The DDEP can be developed through a series of collaboration meetings. The number of meetings would depend on the size and complexity of the project.

The following chapter provides guidance on filling out the different sections of the plan.

Digital Delivery Execution Planning

Each project team planning to follow the digital delivery approach will be required to create a DDEP. At a minimum, the DDEP should:

- Document project objectives.
- Define the requirements for developing and delivering design models.
- Develop the process map for each digital delivery use case utilizing the example templates in Appendix B.
- Specify the internal project team information exchanges, coordination between disciplines and milestone deliverables.
- Define roles and responsibilities for project team members as it relates to digital delivery during the project development lifecycle.
- Provide a software matrix of products and versions being used, including design authoring software (e.g., ORD, OBM), common data environment (e.g., ProjectWise), design review programs (e.g., ProjectWise Design Review).
- Describe a plan for migrating data from previous versions of the software if applicable.

- Define quality assurance and model review procedures.

Digital Delivery Execution Plan Development

The development of a DDEP is a collaborative process that is started at the scoping phase of the project and formalized during project startup. Having a scoping level DDEP is critical to agreeing in general terms to digital delivery requirements for the project, for the purposes of determining scope, schedule, and level of effort. The DDEP is developed by the project team and reviewed by the Digital Delivery Section.

The DDEP can be developed through a series of collaborative meetings, in person, virtually or hybrid. The goal of the collaborative meetings is to identify project model goals and use cases, based on the project deliverables, review and revise the use case process maps and, defining and documenting the roles and responsibilities, software, and quality assurance procedures.

During the project, the DDEP will be reviewed and updated to reflect any changes to goals, key personnal, delivery dates, software/version or changes to other project requriements at each milestone submission or whenever there are major changes. (DDEP Revision Table)

Digital Delivery Execution Plan Template

The DDEP template is divided into eight sections:

1. Introduction
2. Project Details & Requirements
3. Project Digital Delivery Requirements
4. Model Development Details
5. Technology Requirements
6. Data Management
7. Collaboration Strategy
8. Deliverable Requirements

The following sections contain instructions and additional information that can be used when filling out the project DDEP. Tables and appendices referred in the sections below correlate to the tables in the DDEP template that can be downloaded from the PennDOT Digital Delivery website.

Template Overview

A clean, up to date, DDEP template should be used for each project following the digital delivery approach.

The headers within the template are set to be edited by the project team when first developing the plan. Double click on the header to update the document version and the project name. (Figure 15)

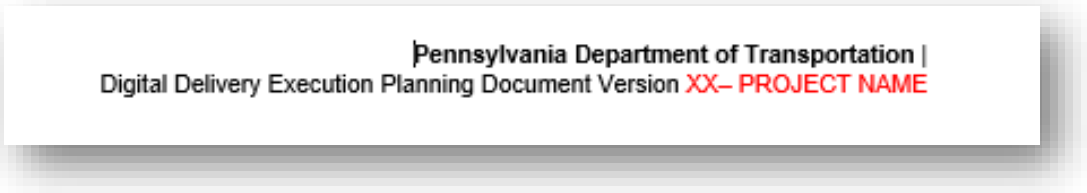


Figure 15. DDEP Header

The table of contents and table index have been set for the initial template page count. To update the tables, left click on the entire table to highlight the contents, select Update Table. This should be done after each revision occurs. (Figure 16)

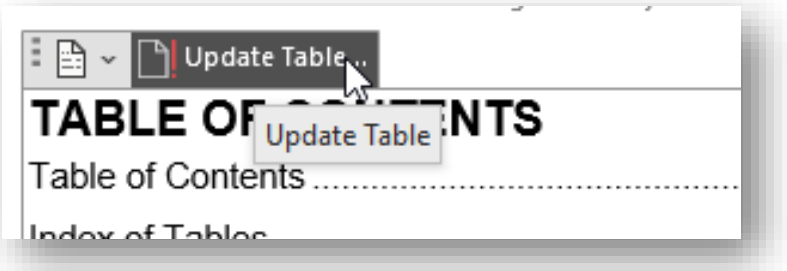


Figure 16. DDEP Update Table

The DDEP Revision Table should be updated at major revisions to the document. The first version will be the initial DDEP document creation. Additional versions can be for milestone revisions, project updates or changes, project staff updates. Additional rows should be added to this table if necessary.

Introduction

The introduction of the DDEP includes the project information and project schedule of milestone submissions of model-based deliverables. It is important to outline all project milestone submissions for PennDOT and other agency and stakeholder submissions.

References

The following references should be used in conjunction with the Digital Delivery Execution Plan to develop the design files and digital deliverables on the project.

- PennDOT Modeling Standards
- Publication 122M
- PennDOT Digital Delivery Interim Guidelines

Project Details and Requirements

DDEP Table 1 provides the basic project reference information that can be quickly referred to by the project team. Additional rows and information can be added to this table depending on project complexity.

Project Schedule and Milestones

The project milestone schedule can be expanded to include various submissions that will include a model deliverable. DDEP Table 2 contains the typical roadway and bridge submissions outlined in Chapter 4 and 5 of these interim guidelines. Rows can be added or removed from the table depending on the project size and complexity. Some examples of additional milestones include:

- Scoping Field View
- Environmental Analysis
- Cultural Resources
- Design Exceptions
- Geotechnical Engineering
- Pavement Design
- Waterway Permits
- Traffic Control
- Pavement Marking and Signing Plan

The start and completion dates can be specific or approximate dates (i.e. May 2 or, Spring 2023). Current status can be set as “In progress”, “completed”, “impacts to schedule”, or left blank if the milestone hasn’t yet been started. This table should be updated throughout the project and uneeded rows can be deleted.

Project Digital Delivery Requirements

This section defines the project uses cases and goals, project discipline objectives, and key digital delivery staff.

PROJECT MODEL USES AND GOALS

The purpose of this section is to identify the core reasons for modeling specific uses cases on the project. The project goals should be specific to the project, measurable, and defined to help improve project collaboration between stakeholders. DDEP Table 3 identifies the model use cases that will be utilized on the project and the associated project goals. The project team will identify which model use cases will be implemented on the project based on the project scope and will also provide specific project details of each use case in conjunction with the example goals.

Table 15 provides high level examples of model use cases and project goals that can be referred to when completing this section of the DDEP. Delete the row If a model use case is not part of the project or add additional rows for more model use cases in DDEP Table 3.

Table 15. Examples of Project Model Use Cases and Goals

Model Use Case	Goal Example	Goal Guidance
Existing Conditions Model	Produce a high quality of existing ground surface, surface features, utilities, and existing infrastructure and assets that will facilitate design confidence.	Project teams should elaborate on specific survey needs for the existing conditions model.
Design Authoring	Produce design models that meet all requirements and functions as specified in the DDEP and contract documents for the purpose of a biddable and buildable project.	Project teams should elaborate on specific disciple models (i.e. roadway, site, bridge, drainage) that will be created on the project.
Visualization (Conceptual Engineering Design)	Support early understanding of project impacts in the existing environment, and interactions between disciplines for the purpose of alternative selection and NEPA.	Project teams should include and elaborate on this goal if a specific model will be created for conceptual design visualizations to help stakeholders make informed project decisions.
Visualization (Stakeholder Involvement)	To make engineering designs more accessible and understandable to the general public for greater transparency and buy in.	Project teams should include and elaborate on this goal if a specific visualization model will be created during design for stakeholder meetings. This model could be used for graphics, videos or fly throughs.
Design Review	Deliver design models that meet PennDOT standards and design criteria, project specific requirements, and design calculations.	Project teams should include and elaborate on this goal if model-based design reviews will occur. Teams should provide a goal that reflects how design reviews will improve the review process.
Temporary Construction Model	Develop design models that coordinate temporary construction situations such as staging, excavation, or detours.	Project teams should include and elaborate on this goal if temporary construction models are to be included in the project. This model could be used for spatial coordination, accurate staging cost estimates or schedule impacts.
Design Quantities	Develop accurate quantity takeoffs to support cost estimation for the project.	Project teams should include and elaborate on this goal if design quantities will be produced from the model. This goal should highlight

		which types of quantities will or will not be utilized from the developed models.
3D Coordination and Clash Detection	Identify potential costly rework, areas for change order avoidance due to conflicts and delays during construction.	Project teams should include and elaborate on this goal for specific model coordination or clash detection issues that may occur during the project.
Digital Delivery Contract Documents (Letting Model)	Deliver a 3D federated design model as the contractual document that will enable contractor bid preparation, construction planning, layout and execution, use of automated machine guided equipment, and initiation of fabrication, inspection.	Project teams should include and elaborate on this goal to define the project needs for digital delivery contract documents.
Digital As-builts (Record Model)	Deliver a digital model that represents the accepted as-built conditions and meets the PennDOT's asset information requirements.	Project teams should include and elaborate on this goal if digital as-built models are required on the project.

KEY DIGITAL DELIVERY PROJECT STAFF

This section defines the key staff roles and digital delivery responsibilities on the project. DDEP Table 4 should be expanded depending on the project size and complexity. This table will be larger for consultant led projects that require subconsultants.

Table 16 describes the roles and digital delivery responsibilities on a project. Refer to Chapter 2 for additional information on roles and responsibilities by project type.

An individual may have one or more digital delivery roles or responsibilities on a project. For example, a roadway design squad model manager may also be the project model manager on a complex project. This individual could be responsible for both the federated design model and reviewing the integrity of the roadway model. If an individual leaves the project DDEP Table 4 should be updated by using the strikeout font effect and adding a new row with the new team member.

If an individual leaves the project prior to completion, the role of that individual will need to be fulfilled by another person. Update DDEP Table 4 throughout the project with additional staff or responsibilities that are added to the project.

Table 16. Key Project Staff Roles

Role	Organization	Digital Delivery Responsibilities
Senior Project Manager	PennDOT	Typical on larger complex projects, the senior project manager is responsible for coordinating milestone reviews.
Project Manager	PennDOT Consultant	Typical on all projects, the project manager is responsible for coordinating milestone reviews and conducting design compliance reviews prior to milestone submissions.
Project Model Manager	PennDOT Consultant	Typical on all projects, the project model manager is responsible for federating model files created by model authors and conducting model integrity and deliverable reviews.
Model Manager (Discipline or Design Squad)	PennDOT Consultant Subconsultant	Typical on larger complex projects, a discipline model manager is responsible for discipline model integrity reviews and providing clean model files to the project model manager prior to federation.
Model Author (Discipline or Design Squad)	PennDOT Consultant Subconsultant	Typical on all projects, the model author is responsible for developing the design model using design authoring software. There may be multiple model authors on a project.

Digital Delivery Section Lead	PennDOT	Typical on all projects, the digital delivery section lead is the PennDOT liaison that assists on digital delivery projects.
District Survey Chief	PennDOT	Typical on all projects, the district survey chief is responsible for coordinating the appropriate survey needs on digital delivery projects.

DIGITAL DELIVERY PROCESS MAPS

When developing the project DDEP, one of the steps is to identify the BIM use case processes that will be utilized on the project. The template process maps have been created for the core processes of each use case and are based on PennDOT project workflows and updated with digital delivery processes. It is important to realize that each project is unique, so there may be different methods a project team could use to achieve a particular process. Refer to the process map section in Chapter 3 and Appendix C: to review the PennDOT process maps.

To fill out DDEP Table 5,identify which model use cases will be used on the project and toggle the checkbox. The next step is to identify if the PennDOT process map will be followed or if a customized project specific map has been developed. Additional process maps for construction can be added to DDEP Table 5 if applicable to the project. These maps include:

- Visualization
- Temporary Construction Model
- Construction Inspection, Verification and Acceptance
- Construction Planning
- Construction Layout
- Shop Model Authoring

Customizing Project Specific Process Maps

Detailed process maps may need to be refined to incorporate additional tasks or software or adjust project team workflows. The PennDOT detailed process maps are provided in Appendix C of this document as a pdf or can be found on the PennDOT Digital Delivery website as a .drawio file type. Process maps can be developed in programs such as Visio, Word, Excel, PowerPoint or customized in Adobe or the free, web-based program, diagrams.net that outputs .drawio file types. To revise a .drawio file type, go to diagrams.net in any web browser and open the selected template that you downloaded to your device. The free online diagram software will allow you to edit and create flowcharts and process maps. Visio and .drawio templates are provided for download on the PennDOT 3D2025 website.

Below are the steps to complete the process map section of the DDEP and includes instructions on customizing the templates.

1. Identify the model use cases that will be used on the project. Toggle the checkbox for “In Project” to indicate the inclusion of the process. Add additional process maps in rows to DDEP Table 5 if necessary. Leave In Project rows untoggled if the process is not in the project.
2. Review the appropriate PennDOT process map templated found in DDEP Appendix A. If the template process maps meet the project needs, skip to Step 8.
3. Collaborate with project team to identify core activites within the detailed processes that need to be customized.
4. Define the dependency between processes to identify the predecessors and successors of each process.
5. Identify reference information and information exchanges needed for the activites.
6. Identify responsible parties for each activity.
7. Place the customize process maps in DDEP Appendix A.
8. Toggle the checkbox for “Project Specific Process Maps” on the appropriate model use case rows in DDEP Table 5.
9. Toggle the checkbox for “PennDOT process maps” on the appropriate model use cases rows which customization was not necessary.

Model Development Details

This section provides the design team details to their approach for meeting the modeling requirements as established within these interim guidelines. The project team will complete the MEBS workbook and use this section to document reviewers for the quality management model development standards review. Refer to **Chapter 3: Model Element Breakdown Structure** on how to fill out the MEBS workbook for the project.

PROJECT MODEL ELEMENT BREAKDOWN STRUCTURE

During the DDEP kickoff meeting, the project team will identify potential model integrity reviewers and list them in DDEP Table 6. This table documents the reviewers of the integrity checks at each milestone of the MEBS file. Identify potential reviewers who will be responsible for integrity checks and update reviewers once the checks have been completed at each milestone.This table should be updated at milestone reviews to check off which MEBS tabs the reviewer has completed.

Technology Requirements

The technology requirements for the project including software, and version control and upgrades are included in this section. Any additional software or upgrade processes should be reviewed by the PennDOT Digital Delivery Section.

DDEP Table 7 documents the project software and versioning that is utilized on the project. The project team should adhere to this list and follow any data migration and software upgrade processes. Model use cases or applications that can be added to DDEP Table 7 include:

Model Use Case	Software Examples
Common Data Environment	ProjectWise
Document Management (If different from CDE)	SharePoint
Existing Conditions Modeling (Survey Processing)	MicroStation, OpenRoads, OpenSite ContextCapture
Design Authoring	MicroStation, OpenRoads, OpenBridge Modeler, Prostructures, Proconcrete
Visualization	ConceptStation, Infraworks, LumenRT, 3DSMax
Design Review	PW365 Design Review, Bluebeam
3D Coordination and Clash Detection	ProjectWise 365 Design Review, iTwin, Navisworks

If a project requires an upgraded version of a software or workspace during the project timeline, an upgrade process is documented to be reviewed by the PennDOT Digital Delivery Section prior to upgrading the software and the project files.

CURRENT SOFTWARE SUPPORTED BY PENNDOT

Current software and tools that are supported by PennDOT are listed in the Modeling Standards Manual. For more information contact the PennDOT Digital Delivery team.

DATA MIGRATION AND SOFTWARE UPDATES

Data migration includes migrating data from legacy versions of software and conversion of different data sources and types, such as GIS or AutoCAD, to project information. The process to migrate this data should be documented in DDEP Table 8.

A software update means a new version of the software has been released and there is no schema change. A software upgrade means a new version of the software with a scheme change has occurred and an update to the workspace is necessary.

If a project requires an upgraded version or update of a software during the project timeline, a process is to be documented and reviewed by the PennDOT Digital Delivery Section prior to upgrading the software and the project files. The project model manager should be in charge of delegating how and when software updates are made. If a new software update is released during the project timeline and the project should not utilize the new version, the model manager should document this in DDEP Table 8.

Data Management

This section documents the project common data environment, coordinate system and Project Digital File Index.

COMMON DATA ENVIRONMENT

The project common data environment is where the project documents and model files are located which provides access and specific permissions to the appropriate team members. DDEP Table 9 provides information of the location, folder structure and any file security measure for the project team.

Under the documentation column the project team should provide the following:

- The link to the project file location, which may either be within the PennDOT ProjectWise or consultant ProjectWise environment. Complex projects may have multiple project file locations for documents and model files. Project teams should document the different locations by adding additional rows to the table.
- Identify the Project Folder structure utilized on the project. This could follow the standard PennDOT folder structure, or a customized folder structure may be created following the proper standards. In the documentation column define if the structure is Standard or Customized.
- File security measures may be applicable to the project and should be documented here. Examples of file security measures include intellectual property, authorized user access, project sensitivity. Typical projects will not need additional file security measures and this row can be left blank.

PROJECT COORDINATE SYSTEM

Document the project coordinate system for this project based on the PennDOT State Plane Coordinate System zones in DDEP Table 10. Refer to the PennDOT Pub 122M for additional information on developing design models in the correct coordinate system.

PROJECT DIGITAL FILE INDEX

The purpose of the Project Digital File Index is to document every digital file submitted at each milestone. The project digital file index should be updated at each milestone submission with every digital file and a short, comprehensive description of what is contained within the file. This index is provided to model reviewers at milestone submissions. Refer to Chapter 3 section on Project Digital File Index Workbook on how to fill out the index. DDEP Table 11 documents the reviewer and date at each milestone who has verified the contents of the index. Rows can be added or deleted to DDEP Table 11 based on project complexity.

Collaboration Strategy

The collaboration strategy sections allow project teams to outline additional scheduled meetings and document who should be invited to them. Another aspect of collaboration is verifying that quality management review process are completed on digital deliverables at every milestone.

Specific collaboration activities should be defined for the project that will establish a recurring frequency. All projects should have a DDEP kickoff meeting and regularly scheduled updates. Additional types of recurring meetings may be applicable for the project depending on size and complexity. Recuring meetings should be documented in DDEP Table 12. Table 17 provides examples of meetings to be considered depending on the project needs.

Table 17. Collaboration Strategy Meetings

Meeting Type	Description	Frequency
DDEP Kickoff	Meet to discuss and develop the DDEP. This may take several collaborative meetings.	Beginning of the project
DDEP Updates	Meet to review the DDEP and update accordingly for project progress.	Milestone submission
Interdisciplinary Reviews	Project team meeting to utilize the 3D models in a federated fashion to perform interdisciplinary coordination reviews. Multiple disciplines may attend these meetings or specific discipline reviews may be scheduled to recur.	Regular intervals during design progression. Frequency dependent on project specifics and schedule.
Over the Shoulder Reviews	Informal meetings to review in progress design development and receive quick feedback from PennDOT, Project Manager, or other disciplines. Depending on the project size and complexity, discipline teams may establish over the shoulder reviews at regular intervals.	Regular intervals during design progression. Frequency dependent on project specifics and schedule, but at a greater rate than interdisciplinary or constructability reviews.
Constructability Reviews	Project team meeting to review the 3D model in a federated fashion to identify constructability issues. Scheduled recurring meetings may be needed for constructability.	Regular intervals during design progression. Frequency dependent on project specifics and schedule.
Agency and Consultant meetings	Consultant led projects may establish recurring meetings with PennDOT leads.	Regular intervals during design progression.

QUALITY MANAGEMENT REVIEW PROCEDURES

This section documents if the quality management model-based reviews have been completed for key milestones. DDEP Table 13 contains typical project milestones for design projects. While this table will not be completed until milestone submissions, the project team can define the project milestones at the beginning of the project.

At each milestone, check off the specific design reviews when completed. If a review is not needed for a particular milestone, delete the checkbox and input “NA” into the cell. Rows can be copied and inserted where appropriate for additional milestones.

PS&E Deliverable Requirements

This section documents the digital delivery requirements and deliverables at PS&E. To complete the table, the project team should identify the types of deliverable items and which file format(s) will be submitted at PS&E for letting. In DDEP Table 14, the project team can add or change file format columns based on the project complexity. Below is a table of example deliverables items and file formats. Refer to Chapter 7: Milestone Design Reviews and Deliverables on how to develop the deliverables and which formats are Legal Document and For Information Only.

Table 18. Example deliverables for PS&E

Deliverable Item	Description	File Format			
		.PDF	.XLXS	.DGN	.LandXML
Existing Conditions Survey	Complex existing terrain surface.	☐	☐	☒	☒
Proposed Conditions Survey	Proposed and existing complex terrain surface consisting of all terrains as a single terrain.	☐	☐	☒	☒
Proposed Breaklines	Corridor points developed into breaklines for AMG.	☐	☐	☒	☒
Proposed drainage models	Drainage models	☐	☐	☒	☐
Proposed bridge models	Bridge models	☐	☐	☒	☐
Proposed utility models	Utility models	☐	☐	☒	☐
Plan sheets	Single project pdf plan sheets, typical sections, details, environmental, traffic control and other sheets that are developed as part of the submission set	☒	☐	☐	☐
Quantity calculations	Quantity calculation	☒	☒	☐	☐
All modeling and sheet files	Container files and individual model files will be packaged together and submitted	☐	☐	☒	☐

References

The content of this document was informed by previous work referenced in this section.

Messner, J., Anumba, C., Leicht, R., Kreider, R., Nulton, E., Ramesh, A., Weiger, D., and Price, K. 2019. “BIM Planning Guide for Facility Owners. ” Computer Integrated Construction Research Program, The Pennsylvania State University, University Park, PA, USA. Available at http://bim.psu.edu.

Pennsylvania Department of Transportation. 2020. “Digital Delivery Directive 2025 Final Strategic Plan.” Retrieved from https://www.penndot.gov/ProjectAndPrograms/3D2025/Documents/Final%20Strategic%20Plan%20V1.0.pdf on 27 June 2021.

Appendix A: Model Element Progression for Design

Model Element Progression for Design

Tables 1-13 provide the MEBS standards for projects using either OpenRoads Designer for roadway corridor modeling or OpenBridge Modeler/Designer for bridge modeling. The MEBS has been designed to follow a typical PennDOT project schedule of deliverables. More detailed requirements for each of model element groups is still being developed as part of future PennDOT modeling development standards. Below are the standard definitions for the element detail and element information that are referenced throughout the tables.

Element Detail Designation	**Definition**
D-1	3D model elements represent general size, shape 2D model elements shown as lines or symbols
D-2	3D model elements represent approximate size, shape 2D model elements represent approximate shape and length Standard or special drawings may be needed to provide graphical details not included in the model element (e.g., reinforcing steel, bolts, connectors)
D-3	3D model elements represent specific size, shape 2D model elements represent specific shape and length Standard or special drawings may be needed to provide graphical details not included in the model element (e.g., reinforcing steel, bolts, connectors)
D-4	3D model element represents the fabrication size, shape, and graphical details. Depiction of design fabrication details to enable quantity takeoffs without the need of standard or special drawings 2D model element represents the fabrication shape and length

Element Information Designation	**Definition**
I-1	Model elements are in a general location and orientation and, contain only dimensional geometric data Element does not have attributes attached; thus information cannot be reliably derived from the model element without notes, dimensions, and special details and/or tables.
I-2	Model elements are in an approximate location and orientation and, can be queried for individual (e.g., each), linear and area (e.g., linear feet, square yards) quantities Notes, dimensions, and details may be needed to obtain further element information. Information attributes may be attached as a placeholder to input detailed information later as the model element progresses in the modeling process
I-3	Model elements are in a specific location and orientation and, element can be queried for individual (e.g., each), linear, area and volumetric (e.g., linear feet, square yards, cubic feet) quantities Attributes containing data pertinent to construction, such as pay item number and material type (Pub 408 specifications) have been added to the model elements and the associated data may be reliably queried
I-4	Model elements are in their exact location and orientation and, can be queried for individual (e.g., each), linear, area and volumetric (e.g., linear feet, square yards, cubic feet) quantities I-3 attributes along with asset data needed for management and maintenance have been added to the model elements and the associated data may be reliably queried

Geometry

Table 1. Geometry Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Reference
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Geometry													
Horizontal Alignment	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 1 - Horizontal Alignment
Superelevation	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 2 - Superelevation
Vertical Alignment	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 3 - Vertical Alignment

FIGURE 1 - HORIZONTAL ALIGNMENT

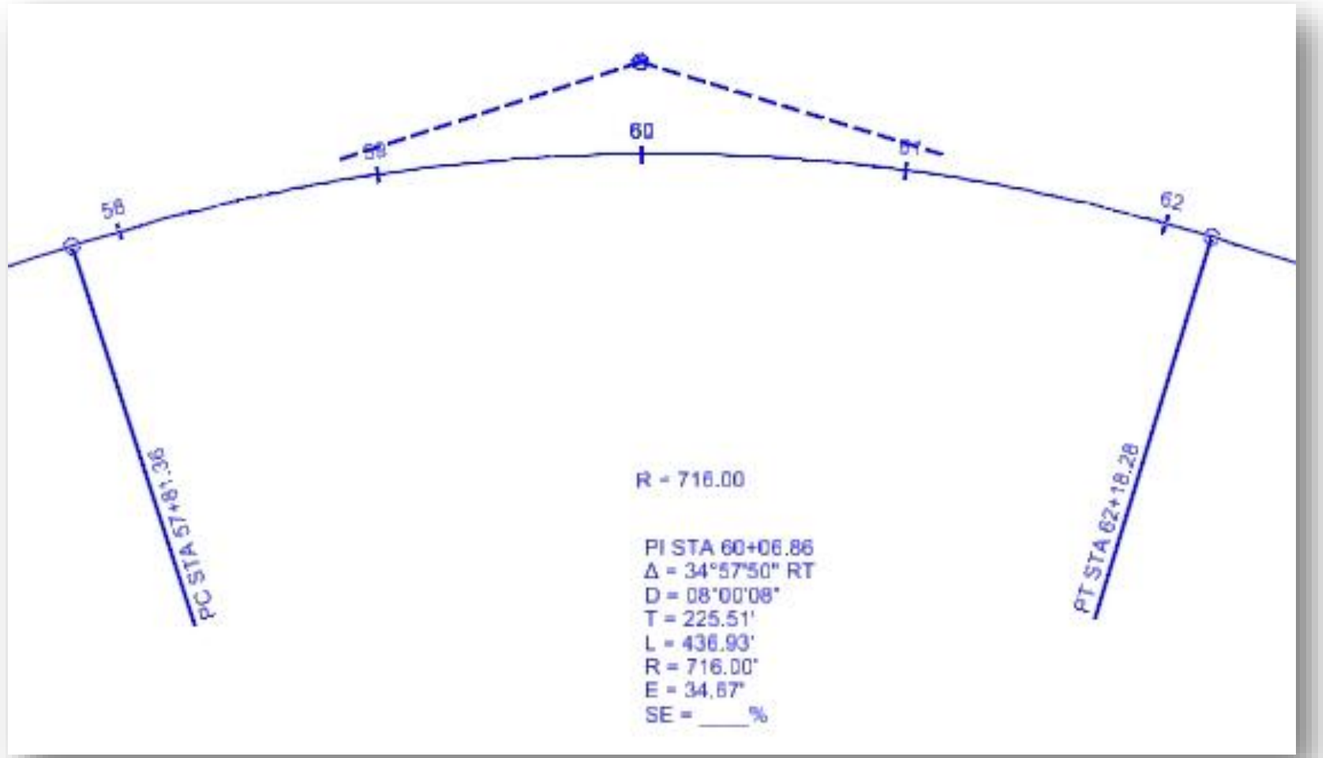
Modeling Criteria	Graphical Representation
Line, Grade and Typical Section (LG&TS) D-2 criteria: Horizontal alignment to be depicted in plan view to determine the general location of the roadway, roadway stationing, horizontal curve data, and bearings. I-2 criteria: Model elements include specific geometric data, including roadway stationing, curve data, bearings, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Horizontal Alignment to be displayed in 2D Model View. Design Field View (DFV) D-2 criteria: Horizontal alignment to be depicted in plan view to determine the approximate location of the roadway, roadway stationing, horizontal curve data, and bearings. I-2 criteria: Model elements include specific geometric data, including roadway stationing, curve data, bearings, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Horizontal Alignment to be displayed in 2D Model View. Final Design Office Meeting (FDOM) D-3 criteria: Horizontal alignment to be depicted in plan view to determine the specific location of the roadway, roadway stationing, horizontal curve data, and bearings I-3 criteria: Model elements include specific geometric data, including roadway stationing, curve data, bearings, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Horizontal Alignment to be displayed in 2D Model View. Plan/Specifications and Estimate (PS&E) D-3 criteria: Horizontal alignment to be depicted in plan view to determine the specific location of the roadway, roadway stationing, horizontal curve data, and bearings I-3 criteria: Model elements include specific geometric data, including roadway stationing, curve data, bearings, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Horizontal Alignment to be displayed in 2D Model View.	 **Example 1 - 2D Representation**

FIGURE 2 - SUPERELEVATION

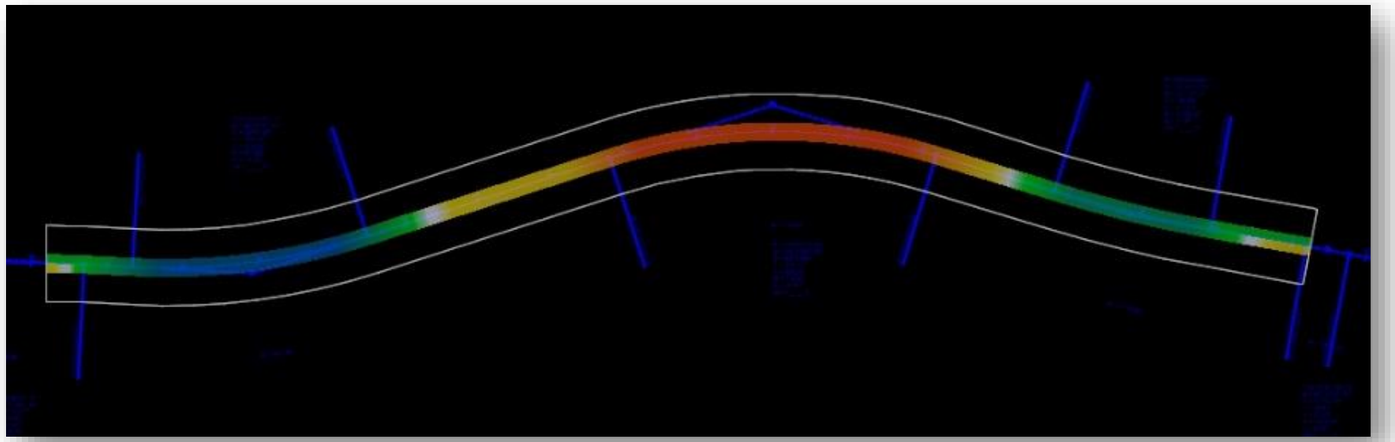
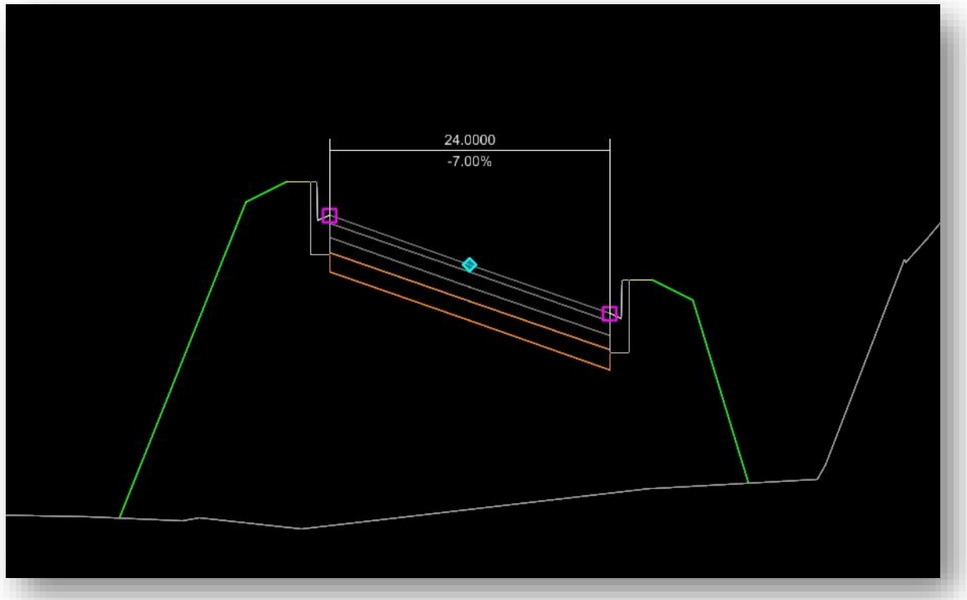
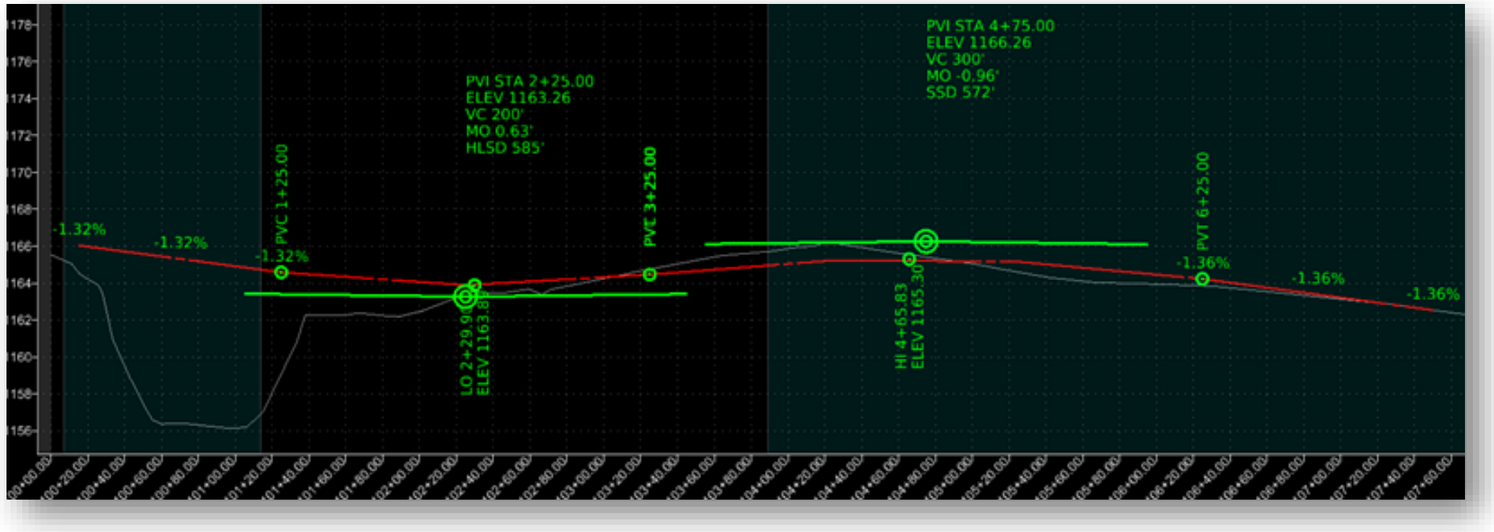
Modeling Criteria	Graphical Representation
Line, Grade and Typical Section (LG&TS) D-1 criteria: Limits of superelevation depicted in plan view. I-1 criteria: Model elements include begin/end of superelevation, proposed lane cross slopes, proposed shoulder cross slopes. 3D Representation: Normal Crown and Superelevated sections to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (S/E Transition locations) in model. Design Field View (DFV) D-2 criteria: Limits of superelevation depicted in plan view. Include cross slope transitions at tie-in locations and bridge approaches. I-2 criteria: Model elements include begin/end of superelevation, proposed lane cross slopes, proposed shoulder cross slopes. 3D Representation: Normal Crown and Superelevated sections to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations in model. Final Design Office Meeting (FDOM) D-3 criteria: Limits of superelevation depicted in plan view. Include cross slope transitions at tie-in locations and bridge approaches, and intersections. I-3 criteria: Model elements include begin/end of superelevation, proposed lane cross slopes, proposed shoulder cross slopes. 3D Representation: Normal Crown and Superelevated sections to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations in model. Plan/Specifications and Estimate (PS&E) D-3 criteria: Limits of superelevation depicted in plan view. Include cross slope transitions at tie-in locations and bridge approaches, and intersections. I-3 criteria: Model elements include begin/end of superelevation, proposed lane cross slopes, proposed shoulder cross slopes. 3D Representation: Normal Crown and Superelevated sections to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations in model.	 **Example 1 - 2D Representation**  **Example 2 - Superelevation in Section**

FIGURE 3 - VERTICAL ALIGNMENT

Modeling Criteria	Graphical Representation
Line, Grade and Typical Section (LG&TS) D-2 criteria: Vertical alignment to be depicted in plan view. Details include proposed longitudinal slopes, curve data, proposed and existing elevations, tie-ins to exiting digital terrain model. I-2 criteria: Model elements include specific geometric data, including roadway stationing, curve data, longitudinal slopes, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Vertical Alignment to be displayed in 2D profile view. Design Field View (DFV) D-2 criteria: Vertical alignment to be depicted in plan view. Details include proposed longitudinal slopes, curve data, proposed and existing elevations, tie-ins to exiting digital terrain model. I-2 criteria: Model elements include specific geometric data, including roadway stationing, curve data, longitudinal slopes, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Vertical Alignment to be displayed in 2D profile view. Final Design Office Meeting (FDOM) D-3 criteria: Vertical alignment to be depicted in plan view. Details include proposed longitudinal slopes, curve data, proposed and existing elevations, tie-ins to exiting digital terrain model. I-3 criteria: Model elements include specific geometric data, including roadway stationing, curve data, longitudinal slopes, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Vertical Alignment to be displayed in 2D profile view. Plan/Specifications and Estimate (PS&E) D-3 criteria: Vertical alignment to be depicted in plan view. Details include proposed longitudinal slopes, curve data, proposed and existing elevations, tie-ins to exiting digital terrain model. I-3 criteria: Model elements include specific geometric data, including roadway stationing, curve data, longitudinal slopes, geometric equalities between existing and proposed horizontal alignments. 3D Representation: 3D. Vertical Alignment to be displayed in 2D profile view.	 **Example 1 - 2D Representation**

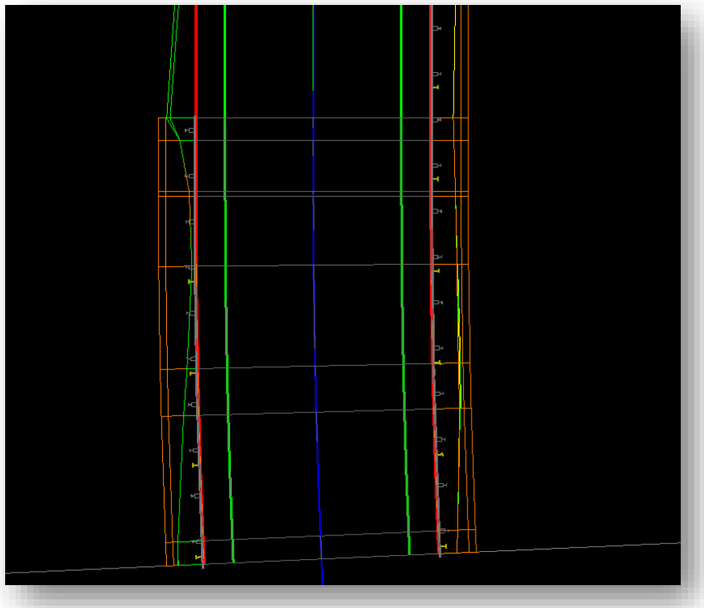
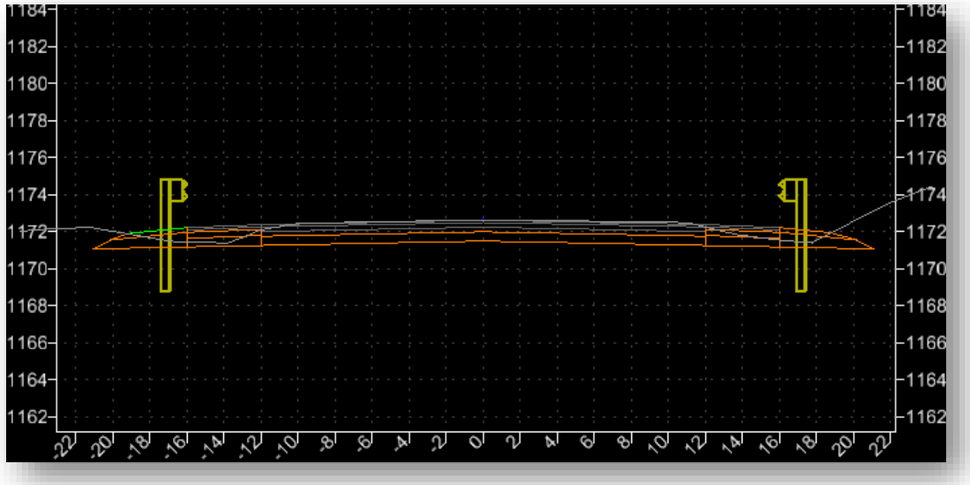
Roadway

Table 2. Roadway Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Reference
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Pavement Structure (Roadway)													
Wearing Course (Flexible, Rigid)	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 4 - Pavement Structure
Leveling	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Scratch	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Relief Joint	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Binder Course	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Base Course	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Subbase (Travel way)	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Tack Coat	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Prime Coat	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Safety Edge	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Shoulders													
Pavement (flexible, rigid)	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 5 - Shoulders
Subbase	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Shoulder Backup	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Graded	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Roadside Development													
Curb	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 6 - Roadside Development
Curb Cuts	D-1	I-1	2D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Gutter	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Sidewalk	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
ADA Ramps	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Median	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	

Driveway Adjustment	D-2	I-1	2D	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Delineator	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Barrier Systems (Traffic)													
Guiderail	D-1	I-1	2D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 7 - Barrier Systems (Traffic)
End Treatments	D-1	I-1	2D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Transitions	D-1	I-1	2D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Barriers	D-1	I-1	2D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Drainage Features (Roadway Features)													
Base Drain	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 8 - Drainage Features (Roadway Items)
Base Drain (Extra Depth)	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Subgrade Drain	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Subsurface Drain	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
End Wall	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Underdrain	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Miscellaneous													
Rumble Strips	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Milling	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Topsoil	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Fence	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	

FIGURE 4 - PAVEMENT STRUCTURE

Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-2 criteria: Approximate location of proposed pavement structure. Locations of pavement relief joint locations and safety edges (if required) will not be identified. Proposed lane widths and begin/end lane taper locations identified. I-1 criteria: Model element information includes generic pavement structure based on roadway classification/typology. 3D Representation: Generic pavement structure to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model. Design Field View (DFV) D-2 Criteria: Approximate location of proposed pavement structure. Locations of pavement relief joint locations and safety edges (if required) will not be identified. Proposed lane widths and begin/end lane taper locations identified. I-2 criteria: Model element information includes pavement structure based on preliminary pavement design. 3D Representation: Preliminary pavement structure to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model.	 **Example 1 - 2D Representation**  **Example 2 - Section Representation**

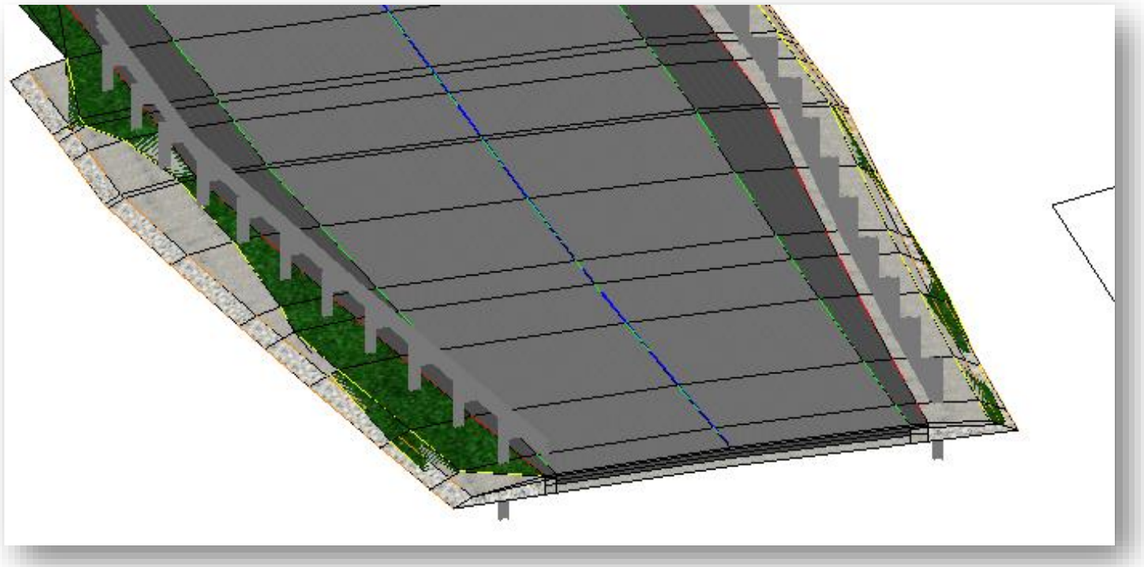
Modeling Criteria	Graphical Representation
Final Design Office Meeting (FDOM) D-3 criteria: Specific location of proposed pavement structure. Specific locations of pavement relief joints and safety edges (if required) will be identified. I-3 criteria: Model element information includes pavement structure based on final pavement design. 3D Representation: Final pavement structure to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model. Plan/Specifications and Estimate (PS&E) D-3 criteria: Specific location of proposed pavement structure. Specific locations of pavement relief joints and safety edges (if required) will be identified. I-3 criteria: Model element information includes pavement structure based on final pavement design. 3D Representation: Final pavement structure to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model.	 **Example 2 - 3D Representation**

FIGURE 5 - SHOULDERS

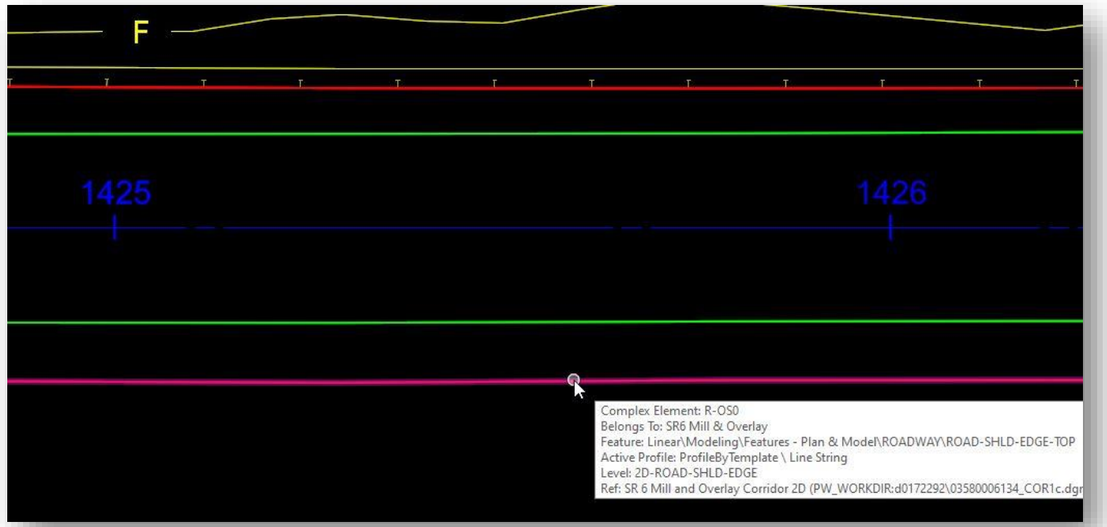
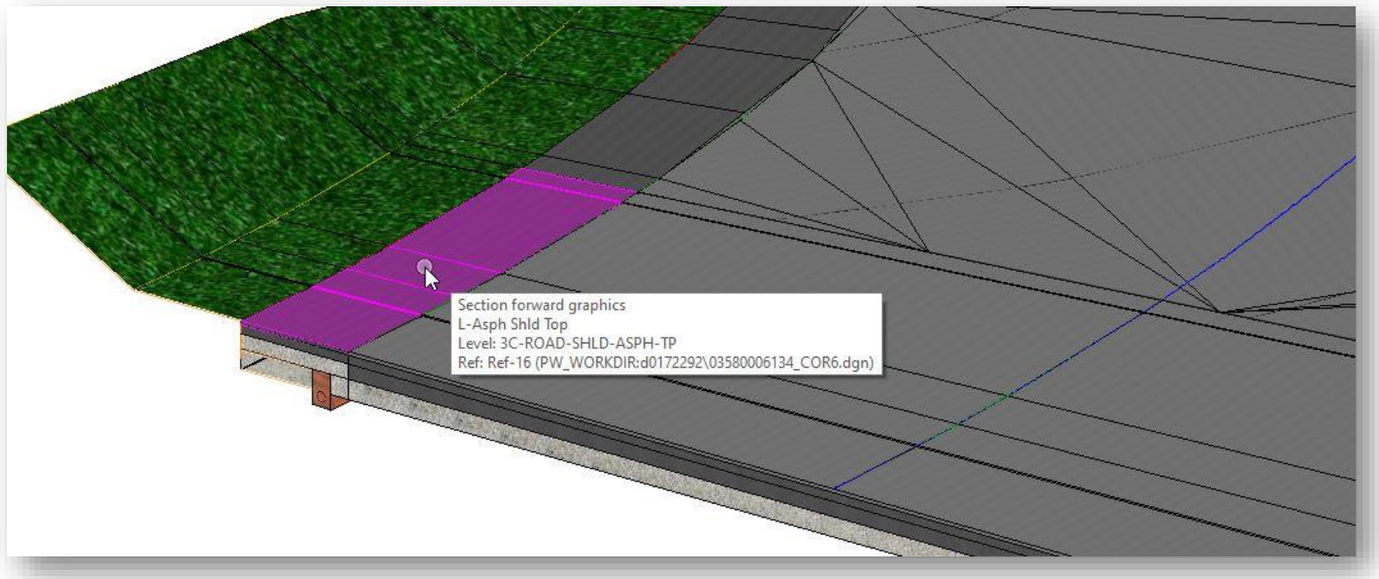
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-2 criteria: Proposed shoulder widths and begin/end shoulder taper locations identified. Locations of graded shoulders vs. paved shoulders identified. I-1 criteria: Model element information includes generic shoulder type selected based on roadway classification. 3D Representation: Generic shoulder types to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model. Design Field View (DFV) D-2 Criteria: Proposed shoulder widths and begin/end shoulder taper locations identified. Locations of graded shoulders vs. paved shoulders identified. I-2 criteria: Model element information includes shoulder type selected based on roadway classification and proposed use. Includes subbase and shoulder backup. 3D Representation: Preliminary shoulder types to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model. Final Design Office Meeting (FDOM) D-3 criteria: Proposed shoulder widths and begin/end shoulder taper locations identified. Locations of graded shoulders vs. paved shoulders identified. I-3 criteria: Model element information includes shoulder type selected based on roadway classification and proposed use. Includes subbase and shoulder backup. 3D Representation: Final shoulder types to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model. Plan/Specifications and Estimate (PS&E) D-3 criteria: Proposed shoulder widths and begin/end shoulder taper locations identified. Locations of graded shoulders vs. paved shoulders identified. I-3 criteria: Model element information includes shoulder type selected based on roadway classification and proposed use. Includes subbase and shoulder backup. 3D Representation: Final shoulder types to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations (Begin/End lane taper locations) in model.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 6 - ROADSIDE DEVELOPMENT

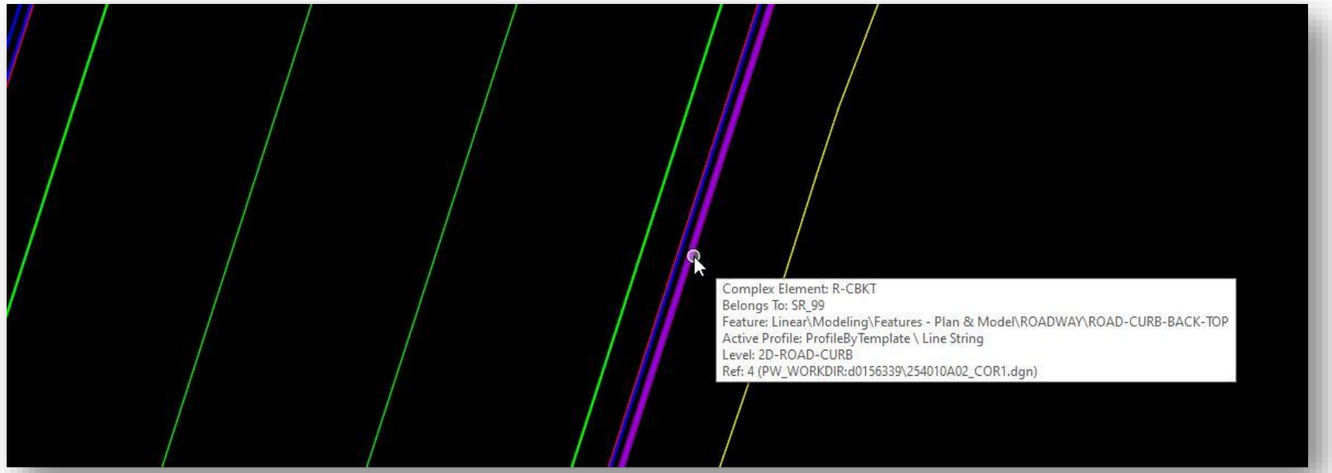
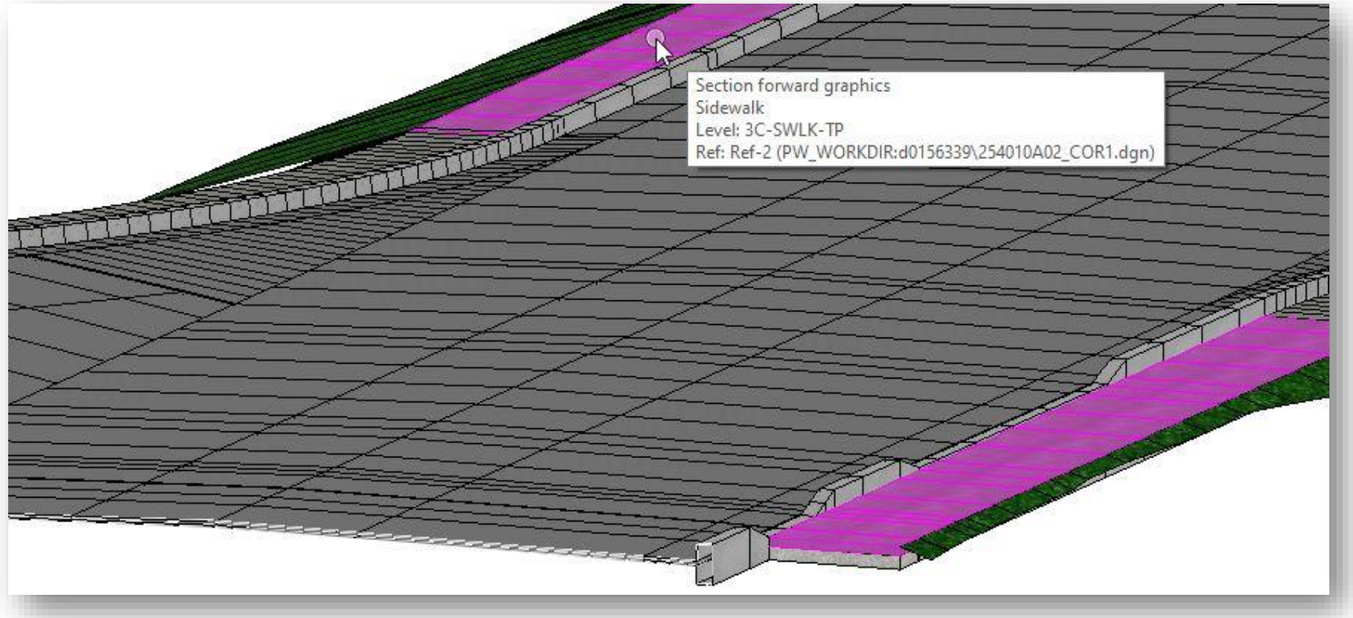
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-2 criteria: Locations of proposed curbs, curb cuts, gutter, sidewalk, medians, and driveway to be depicted. Anticipated type and location of ADA Curb Ramps to be depicted. I-1 criteria: Model element information includes general location of proposed curbs, curb cuts, gutter, sidewalk, medians, and driveways. 3D Representation: Roadside development items to be shown in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations in model. Proposed ADA Curb Ramps and Driveway adjustments to be depicted in 2D. Design Field View (DFV) D-2 Criteria: Locations of proposed curbs, curb cuts, gutter, sidewalk, medians, and driveway to be depicted. Anticipated type and location of ADA Curb Ramps to be depicted. I-2 criteria: Model element information includes general location of proposed curbs, curb cuts, gutter, sidewalk, medians, and driveways. 3D Representation: Roadside development items to be shown in roadway model. Identify driveway adjustments and include in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations in model. Proposed ADA Curb Ramps to be depicted in 2D. Final Design Office Meeting (FDOM) D-3 criteria: Locations of proposed curbs, curb cuts, gutter, sidewalk, medians, and driveway to be depicted. Specific type and location of ADA Curb Ramps to be depicted. I-3 criteria: Model element information includes general location of proposed curbs, curb cuts, gutter, sidewalk, medians, driveways, and ADA curb ramps. 3D Representation: Roadside development items to be shown in roadway model. Identify driveway adjustments and include in roadway model. ADA Curb Ramp design to be included in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations in model. Plan/Specifications and Estimate (PS&E) D-3 criteria: Locations of proposed curbs, curb cuts, gutter, sidewalk, medians, and driveway to be depicted. Specific type and location of ADA Curb Ramps to be depicted. I-3 criteria: Model element information includes general location of proposed curbs, curb cuts, gutter, sidewalk, medians, driveways, and ADA curb ramps. 3D Representation: Roadside development items to be shown in roadway model. Identify driveway adjustments and include in roadway model. ADA Curb Ramp design to be included in roadway model. Minimum modeling interval to be set per PennDOT modeling standards. Identify and include critical locations in model.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 7 - BARRIER SYSTEMS (TRAFFIC)

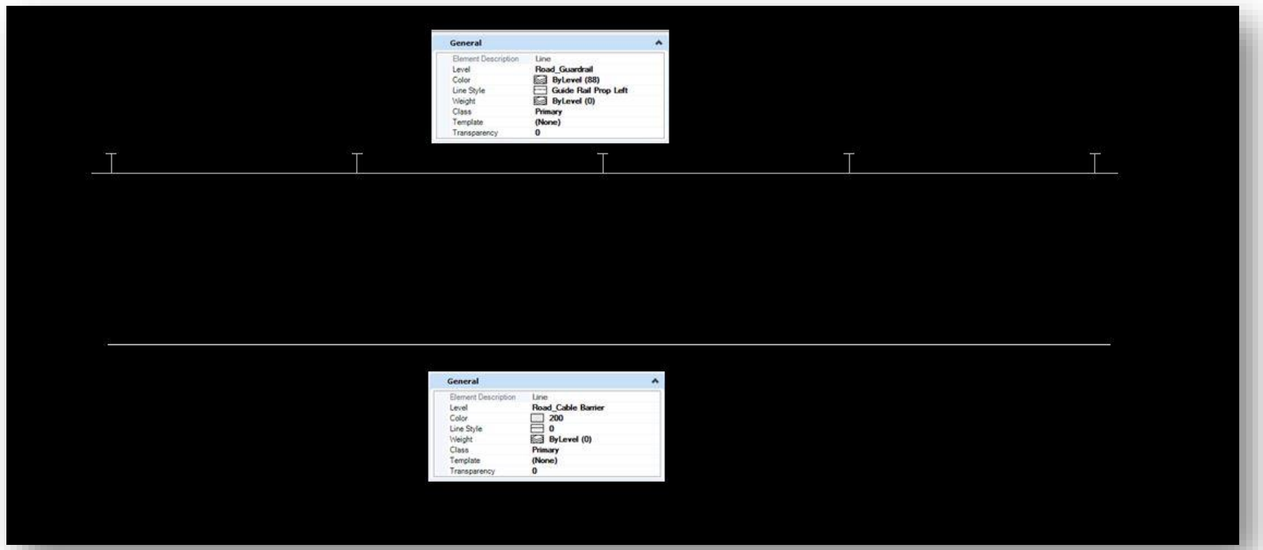
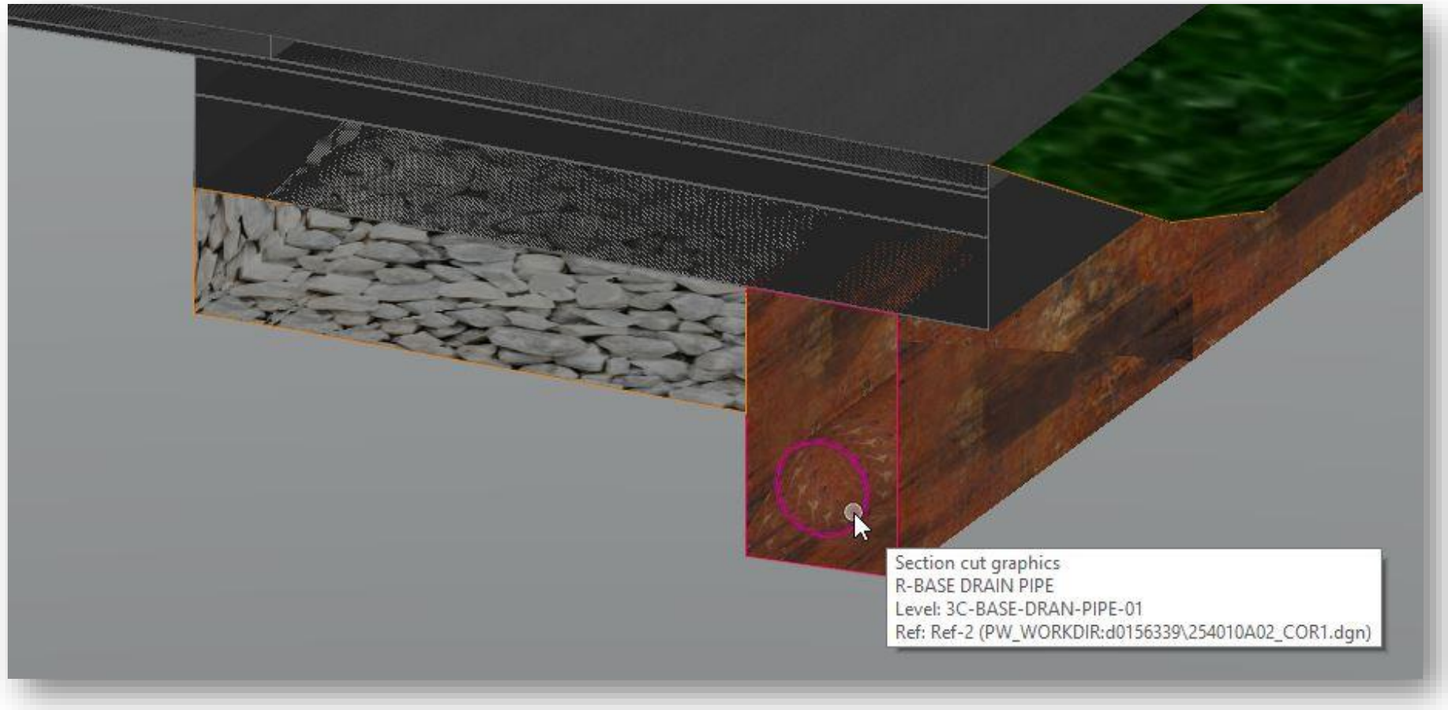
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Anticipated locations of proposed guide rail, end treatments, and barriers to be depicted. I-1 criteria: Model element information includes guide rail, end treatments, and barriers. 3D Representation: 2D representation. Design Field View (DFV) D-2 Criteria: Locations of proposed guide rail, anchors, end treatments, and barriers to be depicted. I-2 criteria: Model element information includes guide rail, end treatments, anchors, and barriers. 3D Representation: 3D Cells of traffic barrier items included in model. Grading requirements for traffic barrier items included in model. Final Design Office Meeting (FDOM) D-3 criteria: Locations of proposed guide rail, end treatments, anchors, and barriers to be depicted. I-3 criteria: Model element information includes guide rail, end treatments, anchors, and barriers. 3D Representation: 3D Cells of traffic barrier items included in model. Grading requirements for traffic barrier items included in model. Plan/Specifications and Estimate (PS&E) D-3 criteria: Locations of proposed guide rail, end treatments, anchors, and barriers to be depicted. I-3 criteria: Model element information includes guide rail, end treatments, anchors, and barriers. 3D Representation: 3D cells of traffic barrier items included in model. Grading requirements for traffic barrier items included in model.	 **Example 1 - 3D Representation**  **Example 2 - 2D Representation**

FIGURE 8 - DRAINAGE FEATURES (ROADWAY ITEMS)

Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: General Pavement Base Drain layout based on the proposed roadway typical sections. Outlet locations, extra depth locations not determined. I-1 criteria: Model element information includes proposed pavement base drain. 3D Representation: Typical Pavement Base Drain installation included in model. Design Field View (DFV) D-2 Criteria: General Pavement Base Drain layout based on the proposed roadway typical sections. Outlet locations, extra depth locations not determined. I-2 criteria: Model element information includes proposed pavement base drain. 3D Representation: Typical Pavement Base Drain installation included in model. Final Design Office Meeting (FDOM) D-3 criteria: All proposed pavement base drain, pavement base drain outlets, locations of extra depth pavement base drain, and subgrade drains have been identified. I-3 criteria: Model element information includes pavement base drain, outlet information, geotextile, additional excavation, and aggregate for extra depth pavement base drain. 3D Representation: Pavement drainage items to be included in the proposed model. Subsurface Drain Outlet End walls to be represented by a 3D Cell. Plan/Specifications and Estimate (PS&E) D-3 criteria: All proposed pavement base drain, pavement base drain outlets, locations of extra depth pavement base drain, and subgrade drains have been identified. I-3 criteria: Model element information includes pavement base drain, outlet information, geotextile, additional excavation, and aggregate for extra depth pavement base drain. 3D Representation: Pavement drainage items to be included in the proposed model. Subsurface Drain Outlet End walls to be represented by a 3D Cell.	 **Example 1 - 3D Representation**

Earthwork

Table 3. Earthwork Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Earthwork													
Clearing and Grubbing (First 8” Topsoil/Organic Material)	D-1	I-1	2D	D-2	I-2	2D	D-2	I-3	2D	D-3	I-3	2D	
Excavation (Class 1A-1C, Class 2-4 and Ditch, and Borrow)	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 9 - Excavation
Embankment (Fill and backfill)	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 10 - Embankment (Fill and Backfill)
Benching	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Drainage Gallery	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Rock Excavation (Blasting for Cut Slopes	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Subgrade (Surface and 3D Breaklines)	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Geotextile	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Geofoam Block	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	

FIGURE 9 - EXCAVATION

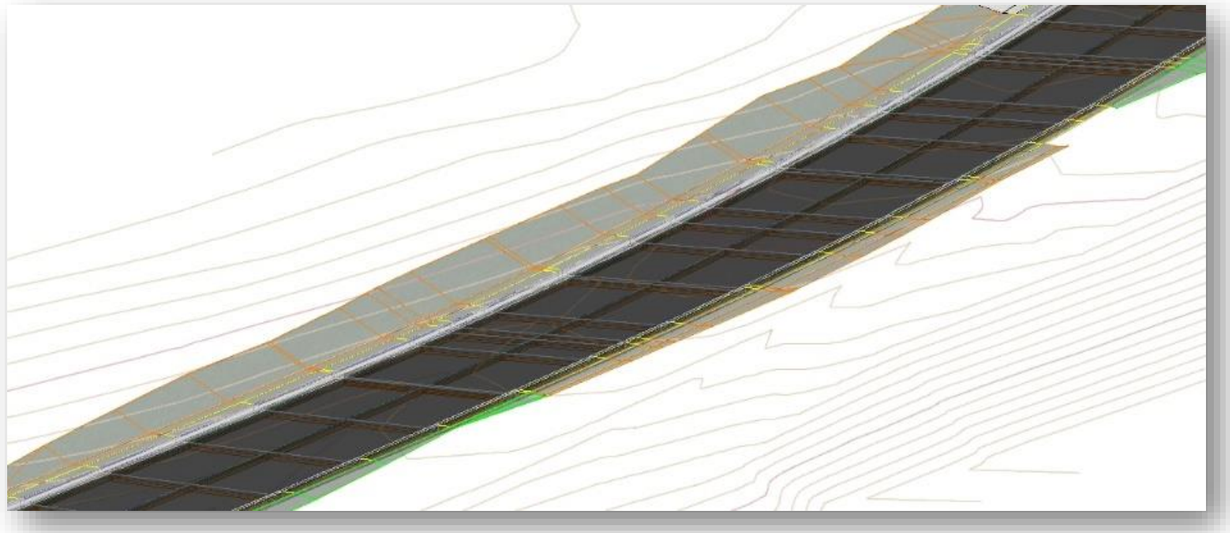
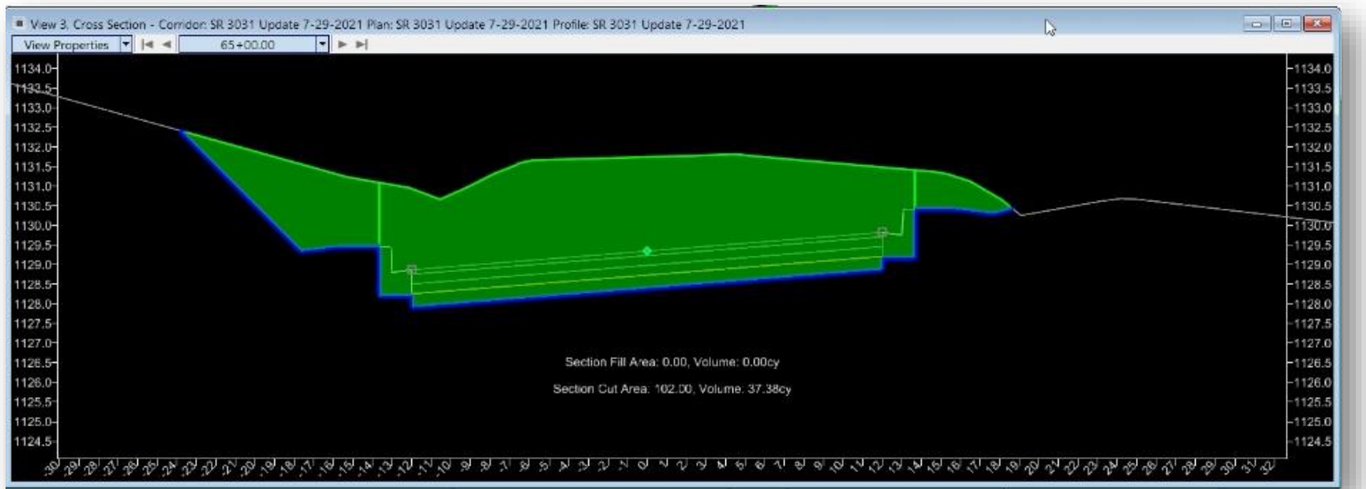
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Identify cut limits to establish clearing and grubbing requirements. Preliminary excavation and embankment to be determined based on preliminary typical sections. Geotechnical treatments (benching, drainage galleries, geotextile) and limits of rock excavation not identified. I-1 criteria: Model element information to include excavation and embankment. 3D Representation: Develop 3D model to include end conditions from preliminary typical sections. Geotechnical treatments, limits of steepened slopes not included at this time. Design Field View (DFV) D-2 criteria: Identify cut limits to establish clearing and grubbing requirements. Preliminary excavation and embankment to be determined based on preliminary typical sections, with steepened slope areas identified. Geotechnical treatments (benching, drainage galleries, geotextile) and limits of rock excavation not identified. I-2 criteria: Model element information to include excavation and embankment. 3D Representation: Develop 3D model to include end conditions from preliminary typical sections, with locations requiring steepened slopes identified. Geotechnical treatments not included at this time. Final Design Office Meeting (FDOM) D-3 criteria: Final cut limits identified. Develop proposed slope benching, drainage galleries, and other geotechnical treatments. Identify limits of rock excavation. Undercutting for removal or unsuitable material? I-3 criteria: Model element information to include excavation, embankment, proposed slope benching, drainage galleries, and other geotechnical treatments. 3D Representation: Develop 3D model to include end conditions from final typical sections, with locations requiring steepened slopes identified. Includes geotechnical treatments and limits of rock excavation. Plan/Specifications and Estimate (PS&E) D-3 criteria: Final cut limits identified. Develop proposed slope benching, drainage galleries, and other geotechnical treatments. Identify limits of rock excavation. Undercutting for removal or unsuitable material? I-3 criteria: Model element information to include excavation, embankment, proposed slope benching, drainage galleries, and other geotechnical treatments. 3D Representation: Develop 3D model to include end conditions from final typical sections, with locations requiring steepened slopes identified. Includes geotechnical treatments and limits of rock excavation.	 **Example 1 – 3D Representation**  **Example 2 – Cross Section Volumes**

FIGURE 10 - EMBANKMENT (FILL AND BACKFILL)

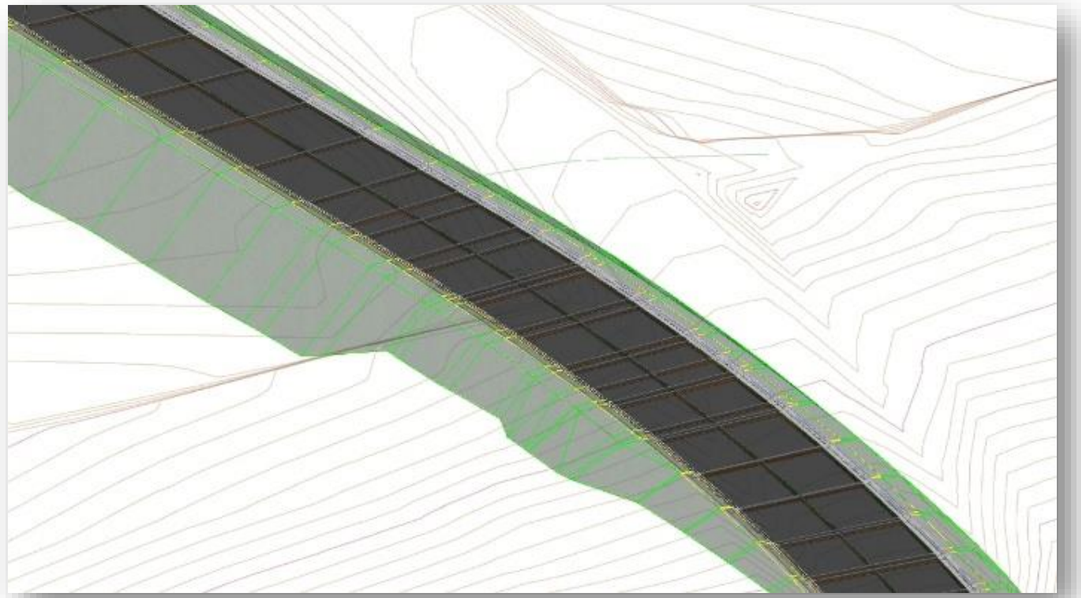
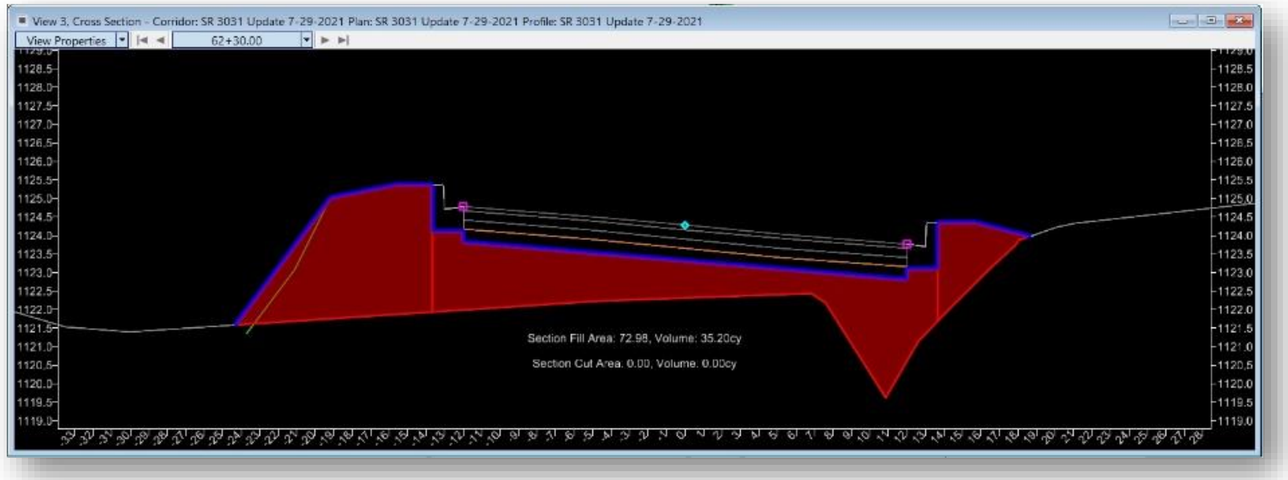
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Identify fill limits to establish clearing and grubbing requirements. Preliminary excavation and embankment to be determined based on preliminary typical sections. Geotechnical treatments (benching, drainage galleries, geotextile) and limits of rock excavation not identified. I-1 criteria: Model element information to include excavation and embankment. 3D Representation: Develop 3D model to include end conditions from preliminary typical sections. Geotechnical treatments, limits of steepened slopes not included at this time. Design Field View (DFV) D-2 criteria: Identify fill limits to establish clearing and grubbing requirements. Preliminary excavation and embankment to be determined based on preliminary typical sections, with steepened slope areas identified. Geotechnical treatments (benching, drainage galleries, geotextile) and limits of rock excavation not identified. I-2 criteria: Model element information to include excavation and embankment. 3D Representation: Develop 3D model to include end conditions from preliminary typical sections, with locations requiring steepened slopes identified. Geotechnical treatments not included at this time. Final Design Office Meeting (FDOM) D-3 criteria: Final fill limits identified. Develop proposed slope benching, drainage galleries, and other geotechnical treatments. Identify limits of rock excavation. Undercutting for removal or unsuitable material? I-3 criteria: Model element information to include excavation, embankment, proposed slope benching, drainage galleries, and other geotechnical treatments. 3D Representation: Develop 3D model to include end conditions from final typical sections, with locations requiring steepened slopes identified. Includes geotechnical treatments and limits of rock excavation. Plan/Specifications and Estimate (PS&E) D-3 criteria: Final fill limits identified. Develop proposed slope benching, drainage galleries, and other geotechnical treatments. Identify limits of rock excavation. Undercutting for removal or unsuitable material? I-3 criteria: Model element information to include excavation, embankment, proposed slope benching, drainage galleries, and other geotechnical treatments. 3D Representation: Develop 3D model to include end conditions from final typical sections, with locations requiring steepened slopes identified. Includes geotechnical treatments and limits of rock excavation.	 **Example 1 – 3D Representation**  **Example 2 – Cross Section Volumes**

Table 4. Bridges and Structures Model Elements

Model Element	H&H Report			TS&L			Foundation Submission			Final Review of Plans			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Deck and Slabs													
Deck	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 11 - Deck
Deck Joints	N/R	N/R	N/R	D-1	I-2	3D	D-1	I-2	3D	D-1	I-3	3D	Figure 12 - Deck Joint
Haunch	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-2	I-3	3D	Figure 13 - Haunch
Precast Deck Panel	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Approach Slabs/Sleeper Slabs	N/R	N/R	N/R	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 14 - Approach Slab/Sleeper Slab
Sidewalk	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 15 - Sidewalk (Bridge)
Barrier/Railing	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 16 - Barrier/Railing (Bridge)
Wearing Surface	N/R	N/R	N/R	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Superstructure													
Prestressed Beam	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-2	I-3	3D	Figure 17 - Prestressed Beams
Steel Girder	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 18. Steel Girder
Stringer	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Floor Beam	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Truss	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Arch	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Closed Web/Segmental Box Girder	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Cable - Primary	N/R	N/R	N/R	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Cable - Secondary	N/R	N/R	N/R	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Pin, Pin and Hanger Assembly, or Both	N/R	N/R	N/R	D-1	I-1	2D	D-1	I-1	2D	D-2	I-3	3D	
Steel Cross Frame or Diaphragm	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	D-3	I-3	3D	Figure 19 - Steel Cross Frame or Diaphragm
Concrete Diaphragm (End and Intermediate & Shear Blocks)	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	D-3	I-3	3D	Figure 20 - Concrete Diaphragm; End and Intermediate and Shear Blocks

Bearing Assembly													
Bearings	N/R	N/R	N/R	D-1	I-1	3D	D-1	I-1	3D	D-2	I-3	3D	Figure 21 - Bearings
Beam Seats/Pedestals	N/R	N/R	N/R	D-1	I-1	3D	D-1	I-1	3D	D-2	I-3	3D	
Appurtenances													
Drainage Structures (on structure)	D-1	I-1	3D	D-1	I-1	3D	D-1	I-1	3D	D-2	I-3	3D	
Structure Mounted Sign Structure	N/R	N/R	N/R	D-1	I-1	3D	D-1	I-1	3D	D-2	I-3	3D	
Structure Mounted Light Poles	N/R	N/R	N/R	D-1	I-1	3D	D-1	I-1	3D	D-2	I-3	3D	Figure 22 - Structure Mounted Light Poles
Substructure and Foundations													
Abutment Wall/Stem	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 23 - Abutment Wall/Stem
Abutment Backwall	D-2	I-1	3D	D-2	I-1	3D	D-2	I-1	3D	D-3	I-3	3D	
Cheek wall	D-2	I-1	3D	D-2	I-1	3D	D-2	I-1	3D	D-3	I-3	3D	
Pier Cap (Multi-column, capped wall pier, etc.)	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 24 - Pier Cap
Columns	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Colum Tower (Trestle)	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Pier Wall	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 25 - Pier Wall
Frame Pier	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Hammer Head Pier (Cantilever Pier)	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Wingwall	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 26 - Wingwall
Drilled Shaft/Caisson	N/R	N/R	N/R	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Steel Pile	N/R	N/R	N/R	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Concrete Pile	N/R	N/R	N/R	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Pile Cap (Integral abutments, bents etc.)	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 27 - Footing/Pile Cap (Integral Abutments, Bents, etc.)
Footing (Shallow Foundation)	N/R	N/R	N/R	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 28 - Spread Footing
Pedestal (Foundation)	N/R	N/R	N/R	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 29 - Bearing Seats/Pedestals
Steel Pile	N/R	N/R	N/R	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	Figure 30 - Steel Pile
Micro Pile	N/R	N/R	N/R	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Other Structures													
Retaining Walls	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	
Retaining Walls (Vendor Designed)	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-2	I-3	3D	
Sound Walls	N/R	N/R	N/R	D-1	I-1	3D	D-1	I-1	3D	D-2	I-3	3D	

Miscellaneous													
Fence	D-2	I-1	3D	D-2	I-1	3D	D-2	I-1	3D	D-3	I-3	3D	
Box Culvert	D-2	I-2	3D	D-2	I-2	3D	D-2	I-2	3D	D-3	I-3	3D	
Existing Bridge Elements	D-2	I-1	3D	D-2	I-1	3D	D-2	I-2	3D	D-2	I-2	3D	
Temporary Structures (Barriers etc.)	D-1	I-1	3D	D-1	I-1	3D	D-1	I-1	3D	D-2	I-2	3D	

Table 5. Structure Element Modeling Comments

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Deck and Slabs				
Deck	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate deck shape is provided; specific minimum thickness and limits in plan view are required, associated features such as reinforcement, chamfers, construction joints, squared-off ends for skew) may not be shown	Approximate deck shape is provided; specific minimum thickness and limits in plan view are required, associated features such as reinforcement, chamfers, construction joints, squared-off ends for skew) may not be shown	Specific deck shape is provided, and reinforcement is included; attribute added for material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, and sealant and protective coating details may be added as supplemental info (2D details, spreadsheets, etc.)
Deck Joints	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General deck joint size is provided, usually as a rectangular block at the dimensions of the opening at 68 deg. F.	General deck joint size is provided, usually as a rectangular block at the dimensions of the opening at 68 deg. F; attributes added for joint type and movement classification	General deck joint size is provided, usually as a rectangular block at the dimensions of the opening at 68 deg. F; attributes added for joint type, movement classification, and pay item(s); associated features such as steel plating to reference standard drawings and/or be included as supplemental info (2D details, spreadsheets, etc.)
Haunch	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate haunch shape is provided with depth accurate for vertical clearance; associated features such as parabolic shape due to PS camber, end of deck adjustments may not be shown	Approximate haunch shape is provided with depth accurate for vertical clearance; associated features such as parabolic shape due to PS camber, end of deck adjustments may not be shown	Approximate haunch shape is provided with depth accurate for vertical clearance; attributes added for concrete class and pay item(s); associated features such as rebar schedules, parabolic shape due to PS camber and additional haunch reinforcement may be added as supplemental info (2D details, spreadsheets, etc.)
Precast Deck Panel	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate deck shape is provided; specific total final depth required; associated features such as chamfers, construction joints for individual panels, squared-off ends for skew may not be shown	Approximate deck shape is provided; specific total final depth required; associated features such as chamfers, construction joints for individual panels, squared-off ends for skew may not be shown	Specific deck shape for individual panels and closure pours is provided but reinforcement is not included; attribute added for material properties, BC Standards references, and pay item(s); associated features such as haunch formwork and connection details may be added as supplemental info (2D details, spreadsheets, etc.)
Approach Slabs/Sleeper Slabs	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	Approximate approach slab and sleeper slab shape is provided; specific limits in plan view are required; associated features such as chamfers, construction joints, squared-off ends for skew may not be shown	Approximate approach slab and sleeper slab shape is provided; specific limits in plan view are required; associated features such as chamfers, construction joints, squared-off ends for skew may not be shown	Specific approach/sleeper slab shape is provided, and reinforcement is included; attribute added for material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, and sealant and protective coating details may be added as supplemental info (2D details, spreadsheets, etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Sidewalk	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate sidewalk shape is provided; specific limits of width required; associated features such as chamfers, construction joints, squared-off ends for skew, may not be shown	Approximate sidewalk shape is provided; specific limits of width required; associated features such as chamfers, construction joints, squared-off ends for skew, may not be shown	Specific sidewalk shape is provided, and reinforcement is included; attribute added for material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, and sealant and protective coating details may be added as supplemental info (2D details, spreadsheets, etc.)
Barrier/Railing	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Type of barrier shown (attribute) with specific limits of height and width required; associated features such as chamfers, construction/deflection joints, squared-off ends for skew, may not be shown	Type of barrier shown (shape and attribute) with specific limits of height and width required; associated features such as railing elements, chamfers, construction/deflection joints, squared-off ends for skew, may not be shown	Specific barrier shape and any primary railing elements are provided (attached to barrier or independent) and reinforcement is included; attribute added for barrier type, material properties, BC Standards references, and pay item(s); associated features such as railing connections, rebar schedules, construction joints for concrete pours, and protective coating details may be added as supplemental info (2D details, spreadsheets, etc.)
Wearing Surface	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	Approximate dimensions are provided; specific type (attribute), thickness, and limits in plan view are required; Also may be incorporated with deck element at this stage as attributes	Approximate dimensions are provided; specific type (attribute), thickness, and limits in plan view are required; Also may be incorporated with deck element at this stage as attributes	Specific wearing surface shape is provided, and reinforcement is included; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for pours, and sealant and protective coating details may be added as supplemental info (2D details, spreadsheets, etc.)
Superstructure				
Prestressed Beam	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as reinforcement/strands, chamfers, paving notches, end block sections, skewed ends) may not be shown	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as reinforcement/strands, chamfers, paving notches, end block sections, skewed ends) may not be shown	Specific prestressed beam shape is provided but prestressing strands/ reinforcement is not included; attribute added for type, concrete grade, BC Standards references, and pay item(s); associated features such as beam daps, notches, debonding, camber, and reinforcing details may be added as supplemental info (2D details, spreadsheets, etc.)
Steel Girder	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Specific steel girder shape is provided including connection plates, stiffeners, and shear connectors; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as camber, connections (welds, bolts, etc.) details may be added as supplemental info (2D details, spreadsheets, etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Stringer	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Specific steel shape is provided including connection plates, stiffeners, and shear connectors; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as camber, connections (welds, bolts, etc.) details may be added as supplemental info (2D details, spreadsheets, etc.)
Floor Beam	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Specific steel shape is provided including connection plates, stiffeners, and shear connectors; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as camber, connections (welds, bolts, etc.) details may be added as supplemental info (2D details, spreadsheets, etc.)
Truss	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Approximate limits provided in plan view and field splice dimensions/locations; specific type (attribute), web thickness/depth, and spacing required; associated features such as shear connectors, stiffeners/connection plates, skewed ends) may not be shown	Specific steel shape is provided including connection plates, stiffeners, and shear connectors; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as camber, connections (welds, bolts, etc.) details may be added as supplemental info (2D details, spreadsheets, etc.)
Arch	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximated arch limits provided in plan view; field splice dimensions/locations; specific type (attribute), arch member thickness/depth, and spacing required; associated features such as stiffeners/connection plates, skewed ends, reinforcement, chamfers, may not be shown	Approximated arch limits provided in plan view; field splice dimensions/locations; specific type (attribute), arch member thickness/depth, and spacing required; associated features such as stiffeners/connection plates, skewed ends, reinforcement, chamfers, may not be shown	Specific arch shape is provided but prestressing strands/reinforcement is not included; attribute added for type, concrete grade, BC Standards references, and pay item(s); associated features such as debonding, camber, and reinforcing details may be added as supplemental info (2D details, spreadsheets, etc.)
Closed Web/Segmental Box Girder	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as reinforcement/strands, chamfers, paving notches, end block sections, skewed ends) may not be shown	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as reinforcement/strands, chamfers, paving notches, end block sections, skewed ends) may not be shown	Specific segmental box girder shape is provided but prestressing and post-tensioning strands/ reinforcement is not included; attribute added for type, concrete grade, BC Standards references, and pay item(s); associated features such as beam notches, camber, and reinforcing details may be added as supplemental info (2D details, spreadsheets, etc.)
Cable - Primary	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as connections may not be shown.	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as connections may not be shown.	Specific steel shape is provided; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as connections (welds, bolted connections, etc.) details may be added as supplemental info (2D details, spreadsheets ,etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Cable - Secondary	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as connections may not be shown.	Approximate limits provided in plan view; specific type (attribute), shape/size, and spacing required; associated features such as connections may not be shown.	Specific steel shape is provided; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as connections (welds, bolted connections, etc.) details may be added as supplemental info (2D details, spreadsheets ,etc.)
Pin, Pin and Hanger Assembly, or Both	Pin and hanger assemblies are a restricted structure type per DM-4 Part A Chapter 2.1	Pin and hanger assemblies are a restricted structure type per DM-4 Part A Chapter 2.1	Pin and hanger assemblies are a restricted structure type per DM-4 Part A Chapter 2.1	Pin and hanger assemblies are a restricted structure type per DM-4 Part A Chapter 2.1
Steel Cross Frame or Diaphragm	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	Typically not a modeling requirement for TS&L	Typically not a modeling requirement for Foundation Submission	Specific steel shape is provided including connection plates, stiffeners, and shear connectors; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as camber, connections (welds, bolts, etc.) details may be added as supplemental info (2D details, spreadsheets, etc.)
Concrete Diaphragm (End and Intermediate & Shear Blocks)	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	Typically not a modeling requirement for TS&L	Typically not a modeling requirement for Foundation Submission	Specific diaphragm and shear blocks shape is provided, and reinforcement is included; diaphragms and shear blocks may be combined with deck or abutment/pier elements; attribute added for material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Bearing Assembly				
Bearings	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions are provided, specific type (attribute) is required	General dimensions are provided, specific type and fixity (attribute) is required	Approximate dimensions are provided, specific bearing height is required; attributes added for bearing type, fixity, and pay item(s); associated features such as exterior/interior elastomeric layers, steel plating to reference standard drawings and/or be included as supplemental info (2D details, spreadsheets, etc.)
Beam Seats/Pedestals	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions are provided	General dimensions are provided	Specific beam seats/pedestals shape is provided, and reinforcement/dowels is included; this may be combined with abutment/pier elements; attribute added for material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Appurtenances				

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Drainage Structures (on structure)	General information (discharge locations, rock placement, etc.) must be provided for H&H report.	General dimensions are provided, type indicated by level naming (not attribute)	General dimensions are provided, type indicated by level naming (not attribute)	Approximate drainage structure shape provided; specific dimensions is required for primary elements (scupper, pipe) but secondary elements and connections are not included; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as grating, connections (welds, bolts, etc.) details may refer to BC-751M or be added as supplemental info (2D details, spreadsheets, etc.)
Structure Mounted Sign Structure	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions are provided, type indicated by level naming (not attribute)	General dimensions are provided, type indicated by level naming (not attribute)	Approximate sign structure shape provided; specific dimensions is provided for primary elements (pipe, panel size, supports attached to bridge) but secondary elements and connections are not included; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as connections (welds, bolts, etc.) details may refer to BC standards or be added as supplemental info (2D details, spreadsheets, etc.)
Structure Mounted Light Poles	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions are provided, type indicated by level naming (not attribute)	General dimensions are provided, type indicated by level naming (not attribute)	Approximate light pole shape provided; specific dimensions is provided for supports attached to bridge) but and connections are not included; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as connections (welds, bolts, etc.), light pole specific details may refer to BC standards or be added as supplemental info (2D details, spreadsheets, etc.)
Substructure and Foundations				
Abutment Wall/Stem	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific front face location required for clear span and horizontal clearance	Approximate dimensions are provided; specific height required for correct bottom of footing	Specific abutment wall/stem shape is provided, and reinforcement is included; attribute added for fixity, material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Abutment Backwall	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific rear face location required for begin and end structure station identification.	Approximate dimensions are provided, specific rear face location required for begin and end structure station identification.	Specific abutment backwall shape is provided and reinforcement is included; backwall may be combined with abutment wall/stem elements; attribute added material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Cheek wall	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided.	Approximate dimensions are provided.	Specific cheekwall shape is provided and reinforcement is included; cheekwall may be combined with abutment wall/stem elements; attribute added material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Pier Cap (Multi-column, capped wall pier, etc.)	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific face location required for clear span and horizontal clearance	Approximate dimensions are provided, specific height required for correct bottom of footing	Specific pier cap shape is provided, and reinforcement is included; attribute added for fixity, material properties, BC Standards references, and pay item(s); associated features such as construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Columns	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific face location required for clear span and horizontal clearance	Approximate dimensions are provided, specific height required for correct bottom of footing	Specific column shape is provided, and reinforcement is included; attribute added material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Colum Tower (Trestle)	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific face location required for clear span and horizontal clearance	Approximate dimensions are provided, specific height required for correct bottom of footing	Specific column tower shape is provided, and reinforcement is included; attribute added material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Pier Wall	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific face location required for clear span and horizontal clearance	Approximate dimensions are provided; specific height required for correct bottom of footing	Specific wall pier shape is provided, and reinforcement is included; attribute added for fixity, material properties, BC Standards references, and pay item(s); associated features such as rebar schedules, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Frame Pier	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific face location required for clear span and horizontal clearance	Approximate dimensions are provided, specific height required for correct bottom of footing	Specific frame pier shape is provided, and reinforcement is included; attribute added for fixity, material properties, BC Standards references, and pay item(s); associated features such as construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Hammer Head Pier (Cantilever Pier)	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific face location required for clear span and horizontal clearance	Approximate dimensions are provided, specific height required for correct bottom of footing	Specific hammer head pier shape is provided, and reinforcement is included; attribute added for fixity, material properties, BC Standards references, and pay item(s); associated features such as construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Wingwall	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions including length are provided, specific orientation (flared or U-wing) is required	Approximate dimensions are provided, specific height required for correct bottom of footing	Specific wingwall shape is provided and reinforcement is included; attribute added for material properties, BC Standards references, and pay item(s); associated features such as construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Drilled Shaft/Caisson	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions and spacing/location indicated; type indicated by level naming (not attribute)	Approximate number and spacing are provided; specific nominal size (including rock socket) and elevations.	Specific drilled shaft/caisson shape is provided (including rock socket) and reinforcement is included; attribute added for material properties, controlling axial and lateral caisson loads and resistances, BC Standards references, and pay item(s); associated features such as foundation/drilling notes and connection details may be added as supplemental info (2D details, spreadsheets, etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Steel Pile	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions and spacing/location indicated; type indicated by level naming (not attribute)	Approximate number and spacing are provided; specific pile type, size, and tip reinforcement noted as attributes and modeled to estimated pile tip elevations.	Specific steel pile shape is provided but pile tip reinforcement and splices not included attribute added for type, material properties, controlling axial and lateral pile loads and resistances, BC Standards references, and pay item(s); associated features such as pile tip reinforcement and splices and foundation notes should refer to BC standards or be added as supplemental info (2D details, spreadsheets, etc.)
Concrete Pile	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions and spacing/location indicated; type indicated by level naming (not attribute)	Approximate number and spacing are provided; specific pile type, size, and tip reinforcement noted as attributes and modeled to estimated pile tip elevations.	Specific concrete pile shape is provided but reinforcement is not included; attribute added for material properties, controlling axial and lateral pile loads and resistances, BC Standards references, and pay item(s); associated features such as foundation notes and connection details may be added as supplemental info (2D details, spreadsheets, etc.)
Pile Cap (Integral abutments, bents etc.)	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions are provided, specific face location required for clear span and horizontal clearance	Approximate dimensions are provided; specific type and depth required for correct bottom of footing elevation	Specific pile cap shape is provided, and reinforcement is included; attribute added for material properties, BC Standards references, and pay item(s); associated features such as foundation notes, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Footing (Shallow Foundation)	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	Typically not a modeling requirement for TS&L	Approximate dimensions are provided; specific type and depth required for correct bottom of footing elevation	Specific footing shape is provided, and reinforcement is included; attribute added for material properties, controlling foundation bearing pressures and resistances, horizontal force for sliding check and resistances, BC Standards references, and pay item(s); associated features such as foundation notes, construction joints for concrete pours, sealant and protective coating, and waterproofing details may be added as supplemental info (2D details, spreadsheets, etc.)
Pedestal (Foundation)	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions and spacing/location indicated; type indicated by level naming (not attribute)	Approximate number and spacing are provided; specific pedestal type and size noted as attributes and modeled to estimated bottom of pedestal elevations.	Specific pedestal foundation shape is provided, and reinforcement is included; attribute added for material properties, controlling foundation bearing pressures and resistances, horizontal force for sliding check and resistances, BC Standards references, and pay item(s); associated features such as foundation notes and connection details may be added as supplemental info (2D details, spreadsheets, etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Steel Pile	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions and spacing/location indicated; type indicated by level naming (not attribute)	Approximate number and spacing are provided; specific pile type, size, and tip reinforcement noted as attributes and modeled to estimated pile tip elevations.	Specific steel pile shape is provided but pile tip reinforcement and splices not included; attribute added for type, material properties, controlling axial and lateral pile loads and resistances, BC Standards references, and pay item(s); associated features such as pile tip reinforcement and splices and foundation notes should refer to BC standards or be added as supplemental info (2D details, spreadsheets, etc.)
Micro Pile	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions and spacing/location indicated; type indicated by level naming (not attribute)	Approximate number and spacing are provided; specific pile type and size noted as attributes and modeled to estimated pile tip elevations.	Specific micro pile shape is provided but connections and pile tip reinforcement are not included; attribute added for type, material properties, controlling axial and lateral pile loads and resistances, BC Standards references, and pay item(s); associated features such as pile tip reinforcement, connections details, and foundation notes should be added as supplemental info (2D details, spreadsheets, etc.)
Other Structures				
Retaining Walls	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions including length and height are provided for each segment, type indicated by level naming (not attribute)	Approximate dimensions are provided; specific height required for correct bottom of footing	Specific retaining wall shape is provided, and reinforcement is included; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as construction joints for concrete pours, sealant and protective coating, and waterproofing details may refer to BC standards and/or be added as supplemental info (2D details, spreadsheets, etc.)
Retaining Walls (Vendor Designed)	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel.	Approximate dimensions including length and height are provided for each segment, type indicated by level naming (not attribute)	Approximate dimensions are provided; specific height required for correct bottom of footing	Approximate retaining wall shape is provided; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as approved product drawings, and additional details for connections, etc. may be added as supplemental info (2D details, spreadsheets, etc.)
Sound Walls	Typically not required, but information may be needed in certain situations for hydraulic analysis considerations.	General dimensions are provided, type indicated by level naming (not attribute)	General dimensions are provided, type indicated by level naming (not attribute)	Approximate sound wall shape provided; specific panel and post dimensions required but connections and reinforcement are not included; attribute added for type, material properties, BC Standards references, and pay item(s); associated features such as expansion joints, sealant and protective coating, and waterproofing, and connection details may refer to BC standards and/or be added as supplemental info (2D details, spreadsheets, etc.)

Model Element	H&H Report	TS&L	Foundation Submission	Final Review of Plans
Miscellaneous				
Fence	Dimensions (height and length) must be specific in order to obtain hydraulic opening (if impacted by fencing elements).	General dimensions are provided, type indicated by level naming (not attribute)	Approximate dimensions are provided, type indicated by level naming (not attribute)	Approximate dimensions are provided; specific height and length required; attributes added for type, pay item(s); associated features such as posts, notes and connection details may refer to BC/RC standards and/or be added as supplemental info (2D details, spreadsheets, etc.)
Box Culvert	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of structure parallel to the channel, type of culvert bottom.	Approximate culvert shape is provided; specific limits for openings and in plan view are required, associated features such as reinforcement, chamfers, construction joints, squared-off ends for skew) may not be shown	Approximate culvert shape is provided; specific limits for openings and in plan view and bottom of culvert elevations are required; associated features such as reinforcement, chamfers, construction joints, squared-off ends for skew) may not be shown	Specific culvert shape is provided including limits for openings and in plan view and bottom of culvert elevations and reinforcement for cast-in-place components are required; attributes added for type, material properties, BC Standards references, and pay item(s); associated features such as reinforcement requirements for precast components, chamfers, construction joints, squared-off ends for skew) may be added as supplemental info (2D details, spreadsheets, etc.)
Existing Bridge Elements	Size, shape, and length must be accurate in order to obtain hydraulic opening, low-chord data, and width of existing structure elements parallel to the channel.	Typically not a modeling requirement for TS&L; Can be required for staging plans, existing abutments/wings depending on project requirements	Approximate dimensions for nearby existing foundations (unless noted below); specific type, footing elevations, and signs of settlement due to scour (attribute) are required. Additional existing structure data required in Foundation Submission letter or plan documents.	Approximate dimensions for nearby existing structure elements; specific dimensions shown if elements are to be used for staged construction analysis or clash detection; associated features such as existing structure information and demolition plans may be added as supplemental info (2D details, spreadsheets, etc.)
Temporary Structures (Barriers etc.)	Size, shape, and length must be accurate in order to obtain hydraulic opening, and width of temporary structures parallel to the channel.	Typically not a modeling requirement for TS&L, Temporary Support of Excavation may be shown based on project requirements.	Typically not a modeling requirement for Foundation Submission, Temporary Support of Excavation may be shown based on project requirements.	Approximate dimensions for temporary structure elements provided; specific dimensions shown if elements are to be used for staged construction analysis or clash detection; associated features such as notes and connection details may refer to BC/RC standards and/or be added as supplemental info (2D details, spreadsheets, etc.)

FIGURE 11 - DECK

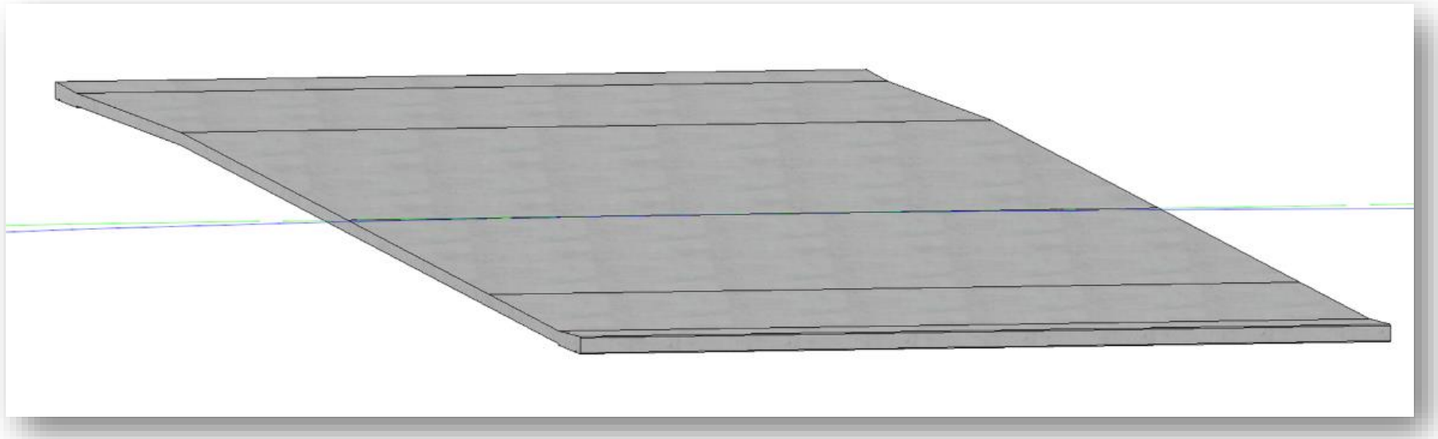
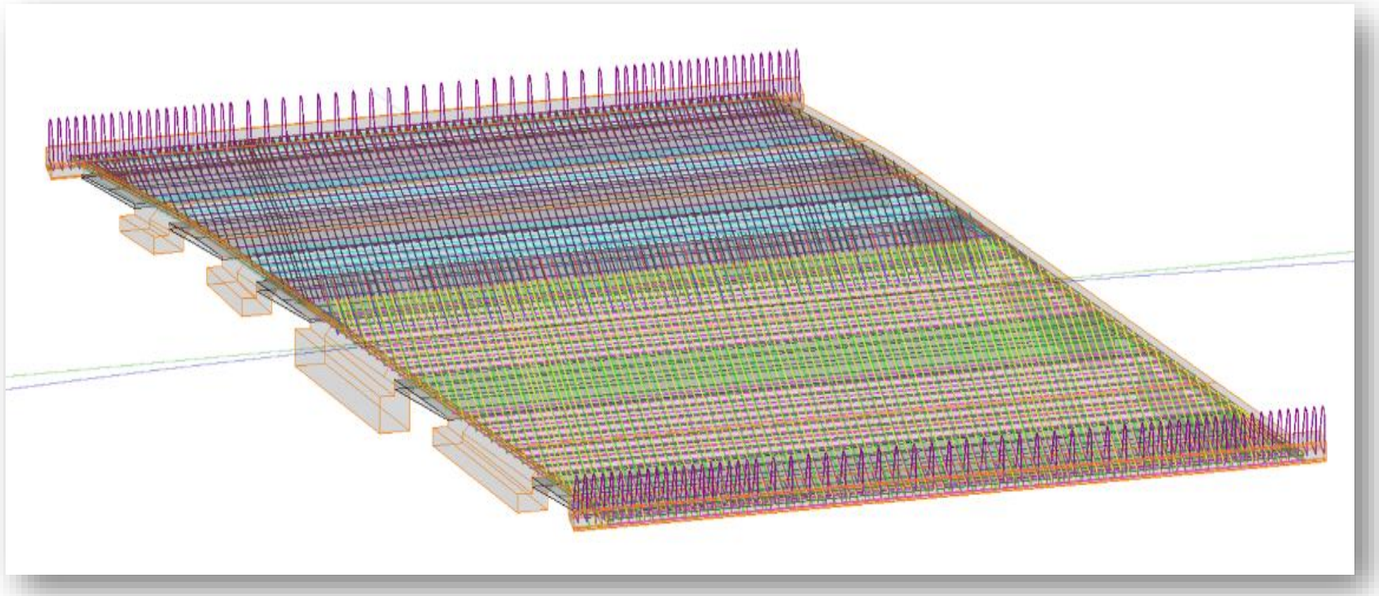
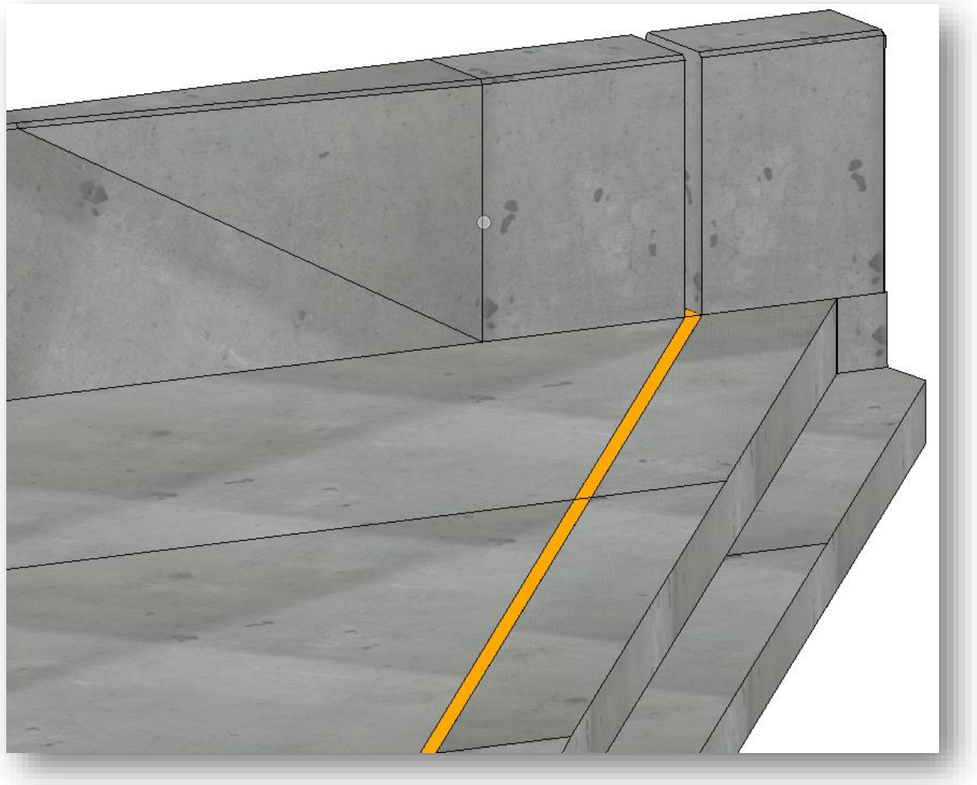
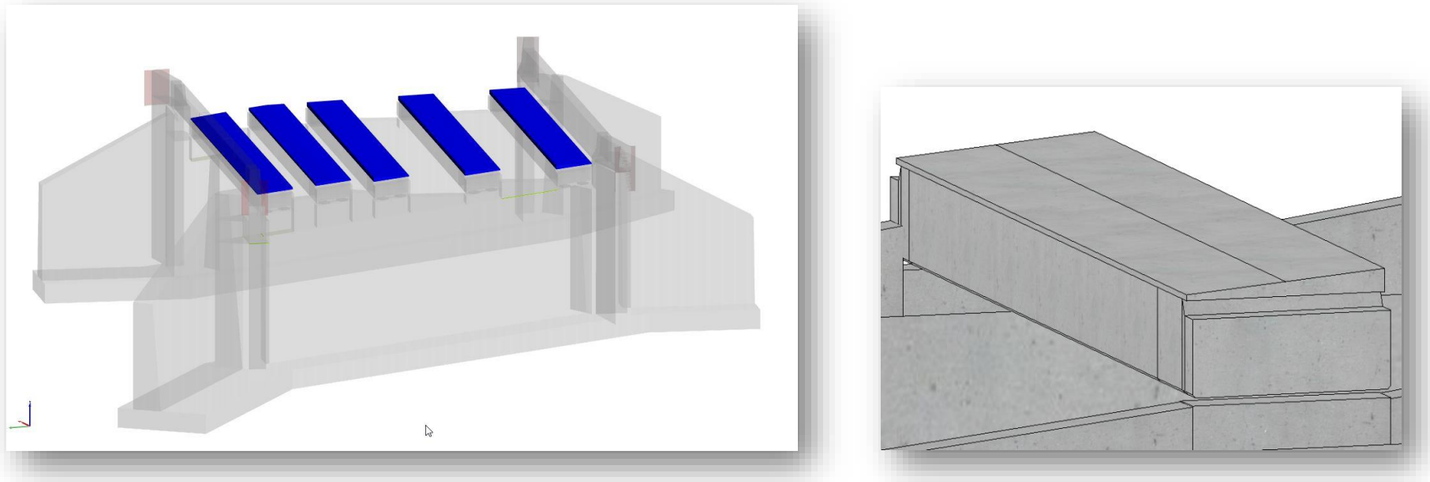
Modeling Criteria	Graphical Representation
H&H Report, TS&L, Foundation Submission D-2 criteria: Approximate deck length, width, minimum thickness, skew, and cross slope/superelevation information are provided. Increased thickness at overhangs is shown but overhangs are not squared off at ends of bridge. Thickened end diaphragms, crown rounding, construction joints and reinforcement are not shown. Details at H&H submission may be limited to that required to provide and accurate hydraulic opening. I-2 criteria: Deck is in the approximate location. Element attributes such as materials and appearances may be provided. Other attributes may be provided as placeholders for later submissions. Element may be used for preliminary area-based quantity takeoffs. Final Review of Plans D-3 criteria: Geometric parameters of previous submission are confirmed, and the deck represents the specific size and shape to be constructed. Deck overhangs are squared off for skewed bridges and thickened end diaphragms are shown. Chamfers, drip notches, crown rounding, and reinforcing is included. Stay-in-place forms and construction joints may be added as supplemental details. Refer to “Conduits” entity for element detail and information designations when present within the deck. I-3 criteria: Deck is in specific location. All construction related attributes such as materials, pay items and construction specifications are included and can be reliably queried. Rebar schedules, top of deck elevations and SIP form volume provided as supplemental information (2D details or spreadsheets). Element may be used for volumetric quantity takeoffs.	 **Example 1 – TS&L & Foundation Submission Deck Element**  **Example 2 – Final Review of Plans & Final Plans Deck Element**

FIGURE 12 - DECK JOINT

Modeling Criteria	Graphical Representation
H&H Report Not required TS&L, Foundation Submission D-1 criteria: General deck joint size, typically provided as a rectangular block with a width equal to the joint size at 68°F. I-2 criteria: Joint type and movement classification should be added as attributes. Joint can be queried for linear feet quantities. Final Review of Plans D-1 criteria: Same as previous submission. Approximate length of joint, including turn-up into barrier may be shown. Steel plates, beams, and rubber extrusions to be added as supplemental details. I-3 criteria: Include additional attributes such as pay items. Joint can be queried for linear feet quantities.	

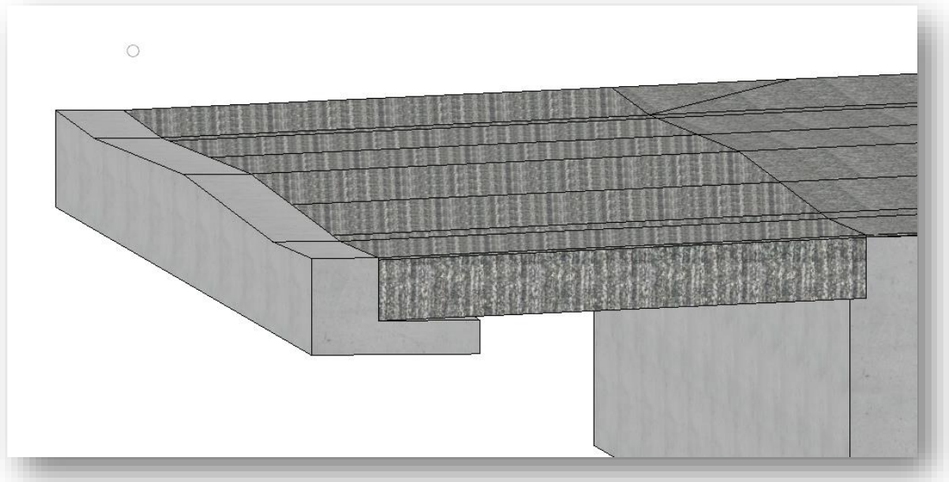
Example 1 – Deck Joint Element for All Submittals

FIGURE 13 - HAUNCH

Modeling Criteria	Graphical Representation
H&H Report, TS&L, Foundation Submission D-2 criteria: Shape and thickness is provided to a level that results in accurate vertical clearance measurements. Variable thickness due to prestressed beam camber may not be shown. Variable width and thickness of haunch on steel plate girders may not be shown. Rebar may be shown in supplemental details. Details at H&H submission may be limited to that required to provide and accurate hydraulic opening. I-2 criteria: Element attributes such as materials and appearances may be provided. Other attributes may be provided as placeholders for later submissions. Final Review of Plans D-2 criteria: No change from previous submissions I-3 criteria: All construction related attributes such as materials, pay items and construction specifications are included. User should be able to determine volumetric quantities. This may require supplemental information or attributes. Rebar schedules to be provided as supplemental detail if rebar is present.	

Example 1 – Haunch Element for All Submittals (deck not shown for clarity)

FIGURE 14 - APPROACH SLAB/SLEEPER SLAB

Modeling Criteria	Graphical Representation
H&H Report Not required TS&L, Foundation Submission D-2 criteria: Approximate slab length, width, minimum thickness, skew, and cross slope/superelevation information are provided. Increased slab thickness at edges, squared off ends, chamfers, construction joints, crown rounding, and reinforcement are not shown. I-2 criteria: Element attributes such as materials and appearances may be provided. Other attributes may be provided as placeholders for later submissions. Element may be used for preliminary area-based quantity takeoffs. Final Review of Plans D-3 criteria: Geometric parameters of previous submission are confirmed, and the slab represents the specific size and shape to be constructed. Slabs are squared off at the corners for skewed bridges and thickened ends are shown. Chamfers, crown rounding, and reinforcing is included. I-3 criteria: All construction related attributes such as materials, pay items and construction specifications are included and can be reliably queried. Rebar schedules provided as supplemental details. Element may be used for volumetric quantity takeoffs.	

Example 1 - Final Review of Plans and Final Plans Approach/Sleeper Slab (see Deck for similar graphical view of TS&L and Foundation Submission)

FIGURE 15 - SIDEWALK (BRIDGE)

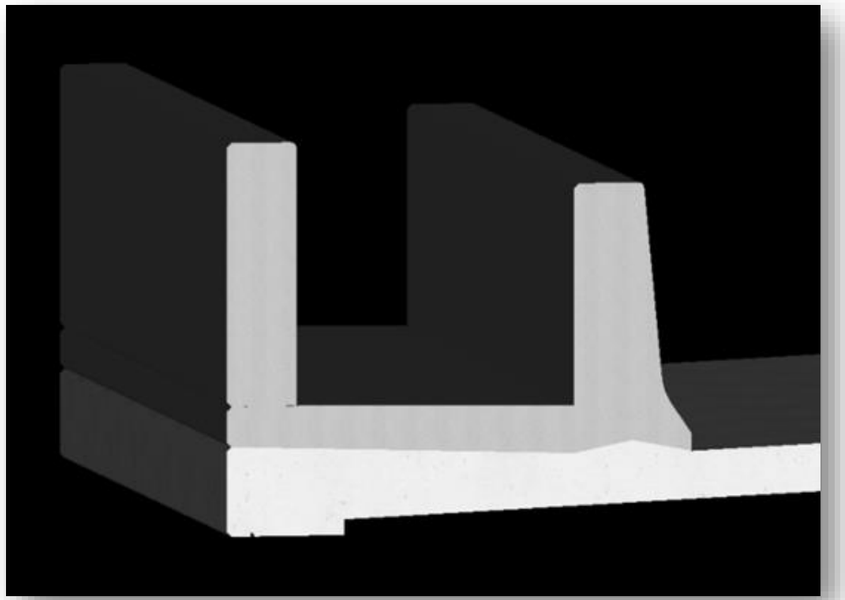
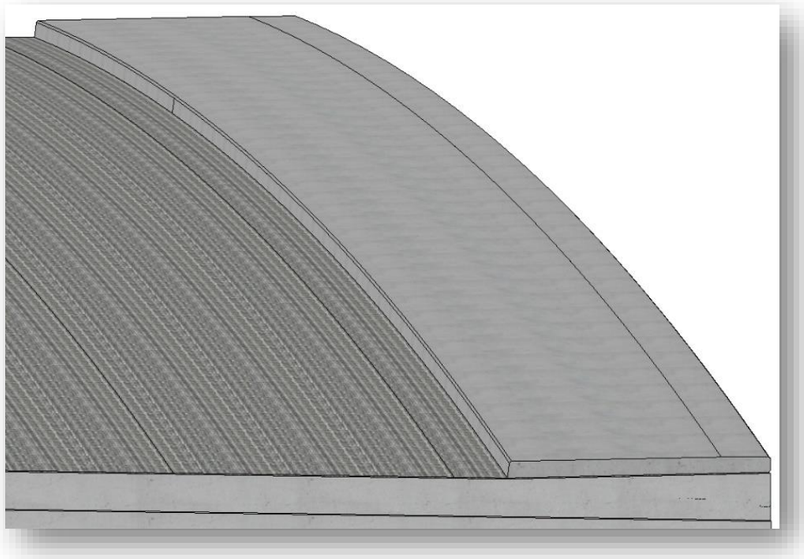
Modeling Criteria	Graphical Representation
H&H Report, TS&L, Foundation Submission D-2 criteria: Approximate plan view shape, thickness, and cross slope details are provided. Squared off ends, chamfers and construction joints may not be shown. Details at H&H submission may be limited to that required to provide and accurate hydraulic opening. I-2 criteria: Element attributes such as materials and appearances may be provided. Other attributes may be provided as placeholders for later submissions. Element may be used for preliminary area-based quantity takeoffs. Final Review of Plans D-3 criteria: Geometric parameters of the previous submission are confirmed or adjusted to the specific size and shape to be constructed. Elements are squared off at ends of skewed bridges. Chamfers and reinforcing are included. Construction joints may be provided in supplemental details. Refer to “Conduits” entity for element detail and information designations when present within the sidewalks. I-3 criteria: All construction related attributes such as materials, pay items and construction specifications are included and can be reliably queried. Element may be used for volumetric quantity takeoffs. Rebar schedules and protective coatings may be provided as supplemental information or attributes.	  **Example 1– Sidewalk (Bridge) Elements for All Submittals (Final Plans will include chamfers and squared off ends for skewed structures)**

FIGURE 16 - BARRIER/RAILING (BRIDGE)

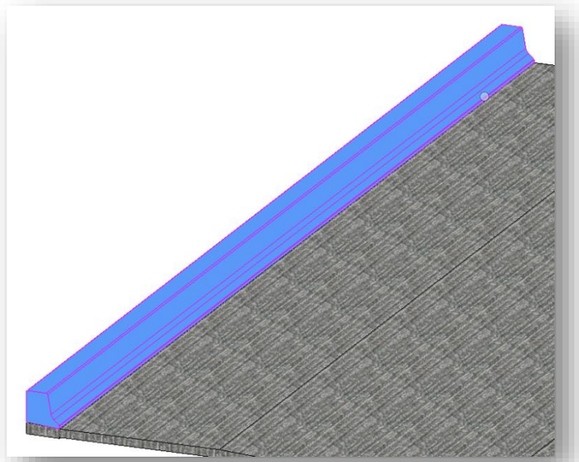
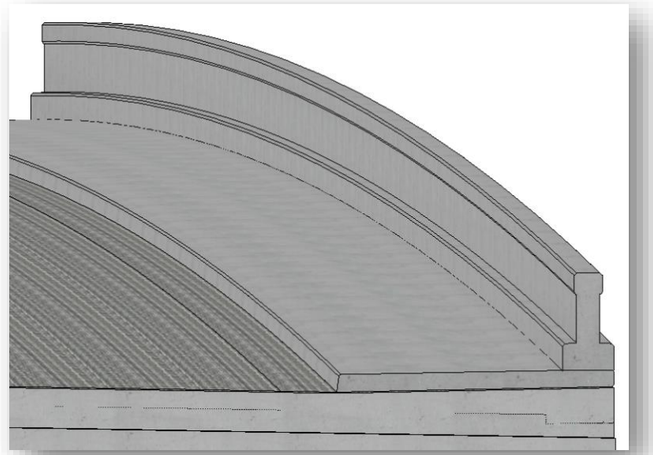
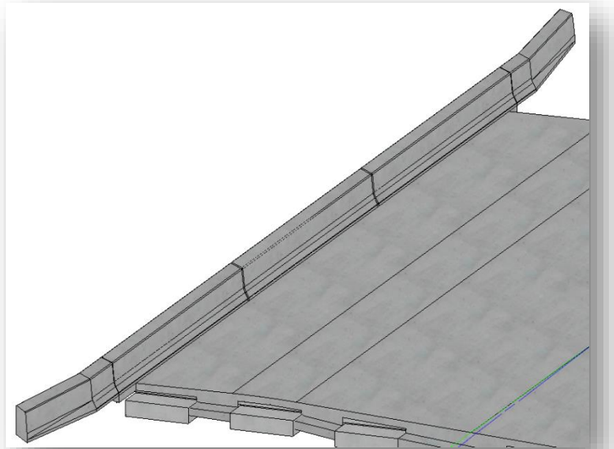
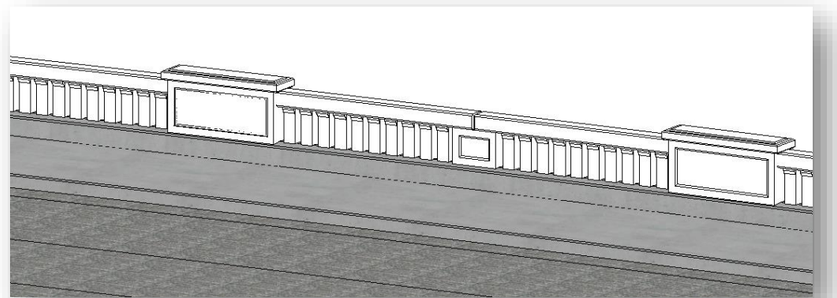
Modeling Criteria	Graphical Representation
H&H, TS&L, Foundation Submission D-2 criteria: Approximate size, shape and length of barrier is provided. Chamfers and barrier transitions may not be shown. Railing to show approximate height and length. Details at H&H submission may be limited to that required to provide and accurate hydraulic opening. I-2 criteria: Attribute for type of barrier shown. Element attributes such as materials and appearances may also be provided. Other attributes may be provided as placeholders for later submissions. Element may be used for preliminary length-based quantity takeoffs. Final Review of Plans D-3 criteria: Specific barrier shape, barrier transitions, end details, chamfers and reinforcing shown. Primary railing elements shown with specific height and length. Railing joint and connection details may be included as supplemental 2D details. Refer to “Conduits” entity for element detail and information designations when present within the barrier. I-3 criteria: Attributes such as barrier type, materials, pay items and construction specifications are included and can be reliably queried. Element may be used for length-based or volumetric quantity takeoffs. Rebar schedules provided as supplemental information.	  **Example 1 – H&H, TS&L, and Foundation Submission Barrier Elements**   **Example 2 – Review of Plans and Final Plans Submission Barrier Elements**

FIGURE 17 - PRESTRESSED BEAMS

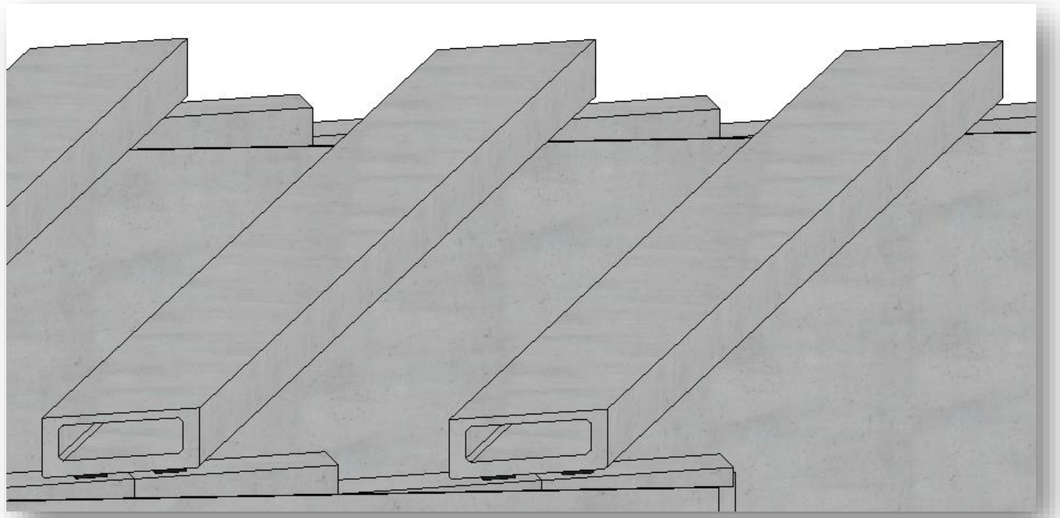
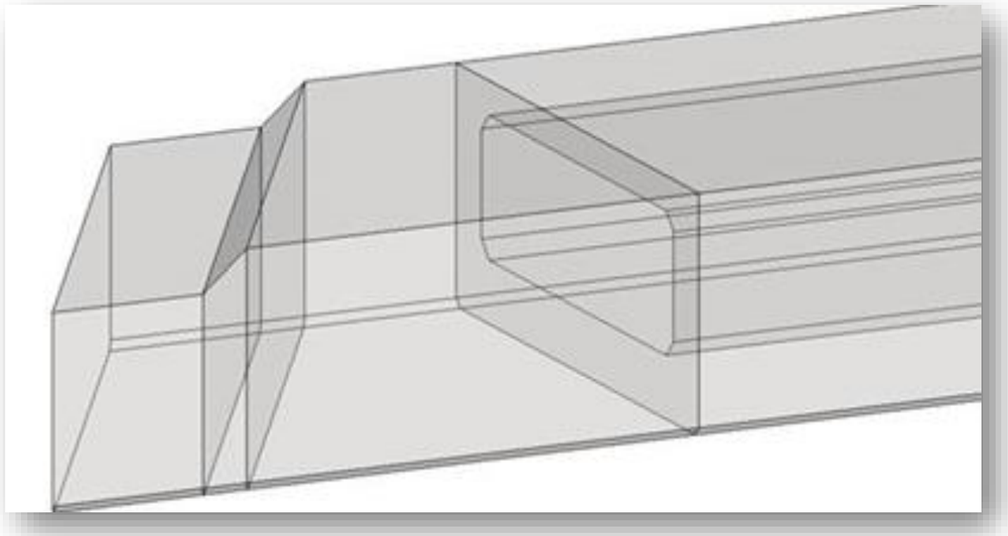
Modeling Criteria	Graphical Representation
H&H, TS&L, Foundation Submission D-2 criteria: Approximate size, shape, length, number and spacing shown. Skewed end details and beam rotation are also shown. I-2 criteria: Include attribute for beam type. Attributes such as materials and appearances may also be provided. Other attributes may be provided as placeholders for later submissions. Element may be used for preliminary length-based quantity takeoffs. Final Review of Plans D-2 criteria: Same as previous submission. Beam reinforcing, prestressing, camber, daps, notches, and holes may be included as separate supplemental details. Refer to “Conduits” entity for element detail and information designations when present within the beam. I-3 criteria: All construction related attributes such as type, materials, pay items and construction specifications are included and can be reliably queried. Element may be used for length-based quantity takeoffs only.	 **Example 1 - H&H, TS&L, and Foundation Submission Prestressed Beam Elements**  **Example 2 - Final Plans Prestressed Beam Element**

FIGURE 18. STEEL GIRDER

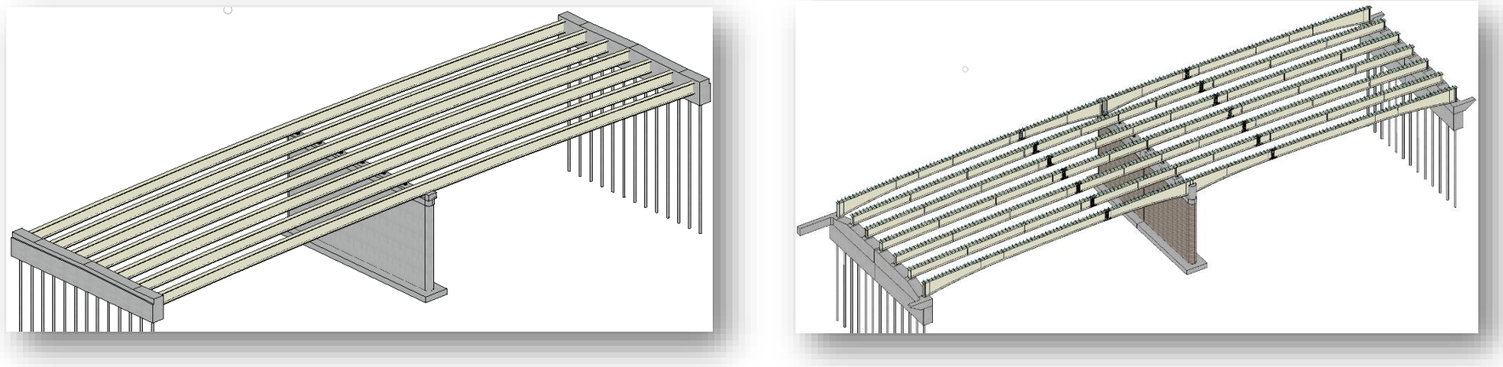
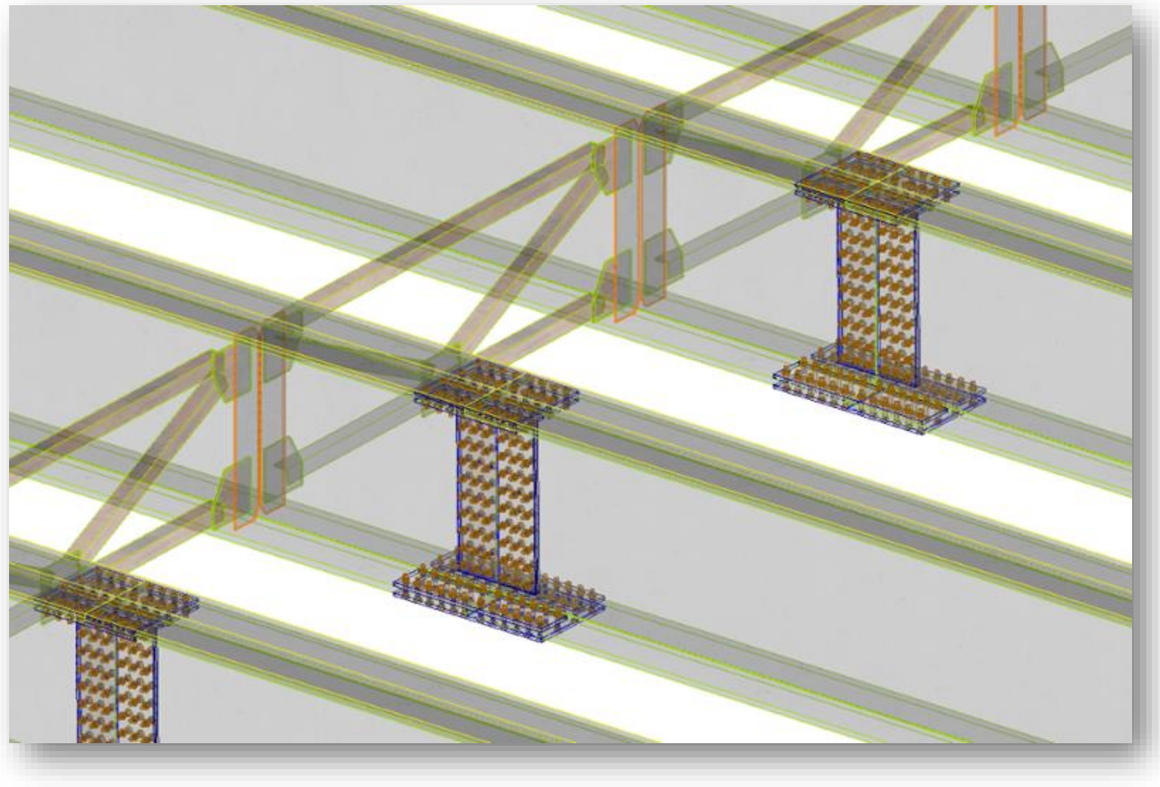
Modeling Criteria	Graphical Representation
H&H, TS&L, Foundation Submission D-2 criteria: Approximate size, shape, length, number, and spacing shown. Items such as shear connectors, field splices, stiffeners, and connection plates need not be shown. I-2 criteria: Element attributes such as materials and appearances may be provided. Other attributes may be provided as placeholders for later submissions. Type of coating system should be indicated. Element may be used for preliminary length-based quantity takeoffs. Final Review of Plans D-3 criteria: Specific steel shape is provided including connection plates, stiffeners, field splices and shear connectors. Features such as beam copes, camber and deflection, connections (welds & bolts) and any other miscellaneous attachments may be provided as supplemental details. Bolts/holes for field splices should be shown. All other bolts/holes may be provided in supplemental details. I-3 criteria: All construction related attributes such as fit condition, type, materials, pay items and construction specifications are included and can be reliably queried. Element may be used for volumetric quantity takeoffs.	 **Example 1 – H&H, TS&L, and Foundation Submission Steel Girder Elements & Overall View**  **Example 2 - Review of Final Plans and Final Plans Steel Girder Elements**

FIGURE 19 - STEEL CROSS FRAME OR DIAPHRAGM

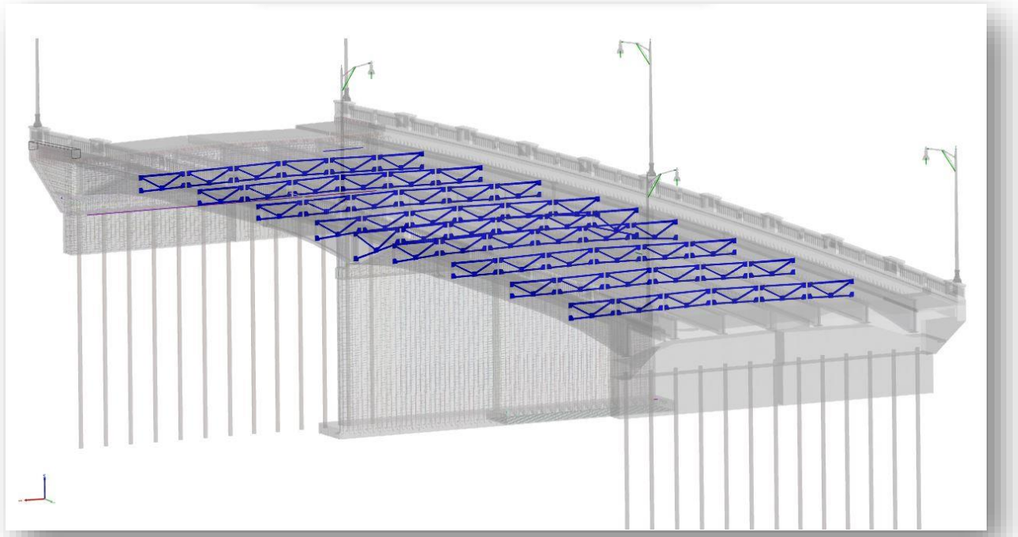
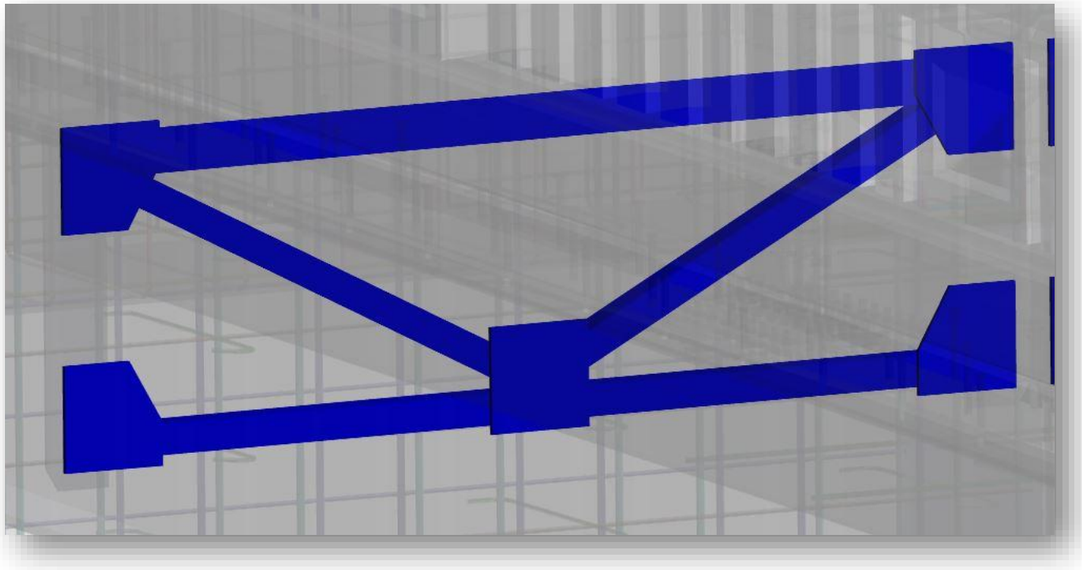
Modeling Criteria	Graphical Representation
H&H, TS&L, Foundation Submission Not Required Final Review of Plans D-3 criteria: Specific steel shapes and member lengths are provided including gusset plates and shear connectors. Features such as end copes and connections (welds & bolts) may be added as supplemental details. I-3 criteria: All construction related attributes such as fit condition, type, materials, pay items and construction specifications are included and can be reliably queried. Elements may be used for volumetric quantity takeoffs.	 **Example 1 – Overall View**  **Example 2 - Detail View**

FIGURE 20 - CONCRETE DIAPHRAGM; END AND INTERMEDIATE AND SHEAR BLOCKS

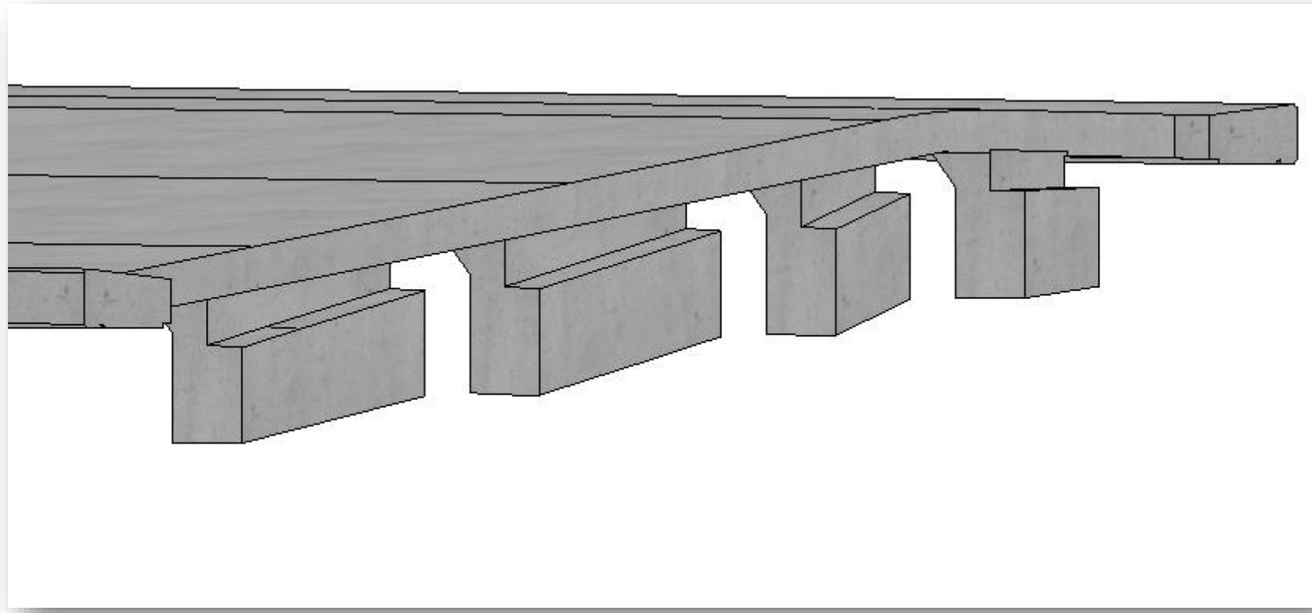
Modeling Criteria	Graphical Representation
H&H, TS&L, Foundation Submission Not Required Final Review of Plans D-3 criteria: Specific diaphragm or shear block shape is provided including reinforcement and chamfers. These elements may be combined with the deck or abutment/pier elements. I-3 criteria: All construction related attributes such as type, materials, pay items and construction specifications are included and can be reliably queried. Rebar schedule to be provided as supplemental information. Elements may be used for volumetric quantity takeoffs.	 **Example 1 – Final Review of Plans and Final Plans Concrete End Diaphragm Element (Beams not shown for clarity)**

FIGURE 21 - BEARINGS

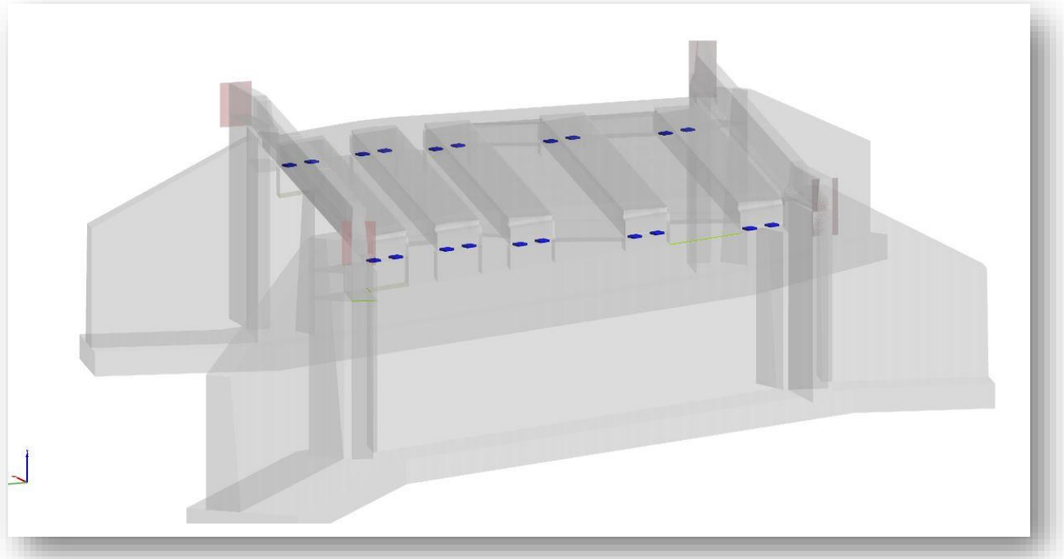
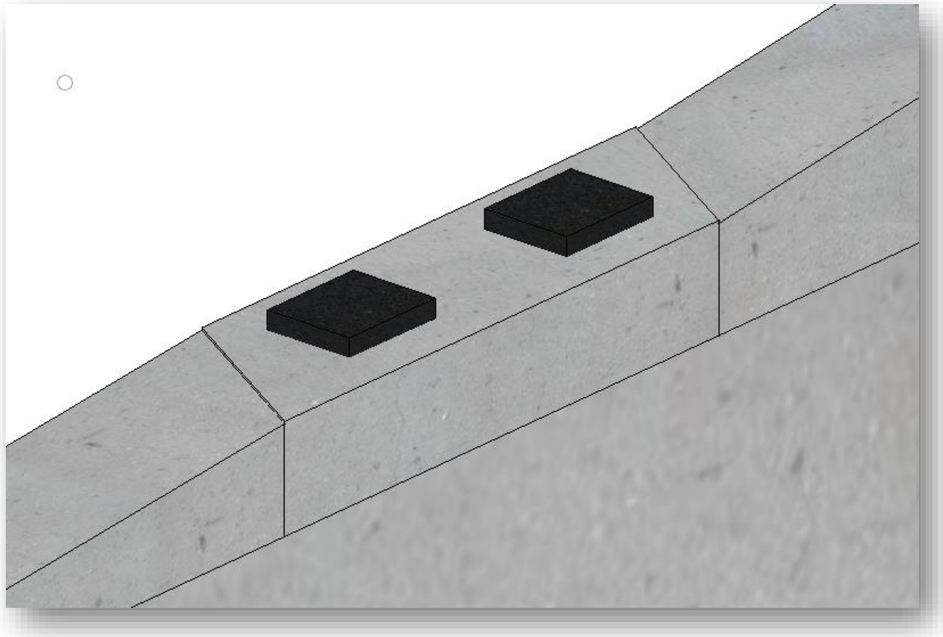
Modeling Criteria	Graphical Representation
H&H, Not required. TS&L, Foundation Submission D-1 criteria: General dimensions of bearing are provided. I-1 criteria: Attribute for preliminary bearing type provided. Bearing fixity should be shown for one and two span structures. Final Review of Plans D-2 criteria: Approximate dimensions are provided. Specific bearing height is required. Details for elastomeric layers, steel plates, anchor bolts may be included as supplemental details. I-3 criteria: Includes attributes such as bearing type, fixity, orientation for thermal movements and pay items are required.	 **Example 1 - Overall View**  **Example 2 – Bearing Elements for All Submissions (exact height required for Final Plans)**

FIGURE 22 - STRUCTURE MOUNTED LIGHT POLES

Modeling Criteria	Graphical Representation
H&H Submission Not required TS&L, Foundation Submission D-1 criteria: Element represents the general size and shape. I-1 criteria: Element is in a general location and orientation. No attributes are assigned. Final Review of Plans D-2 criteria: Approximate pole shape and height provided. Specific dimensions for connection to bridge, but secondary elements and connections may be provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications and pay items.	

Example 1 – Structure Mounted Light Pole Element for All Submissions (graphically similarly)

FIGURE 23 - ABUTMENT WALL/STEM

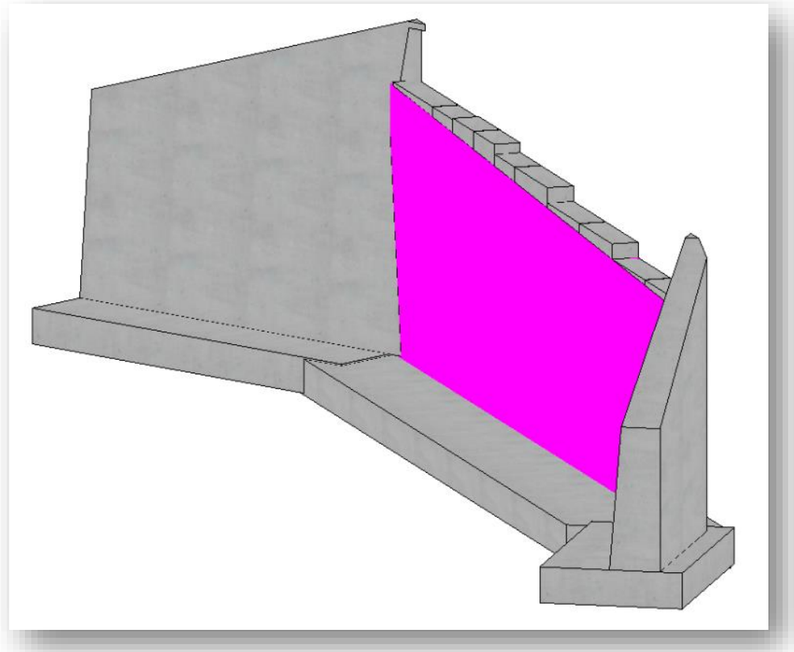
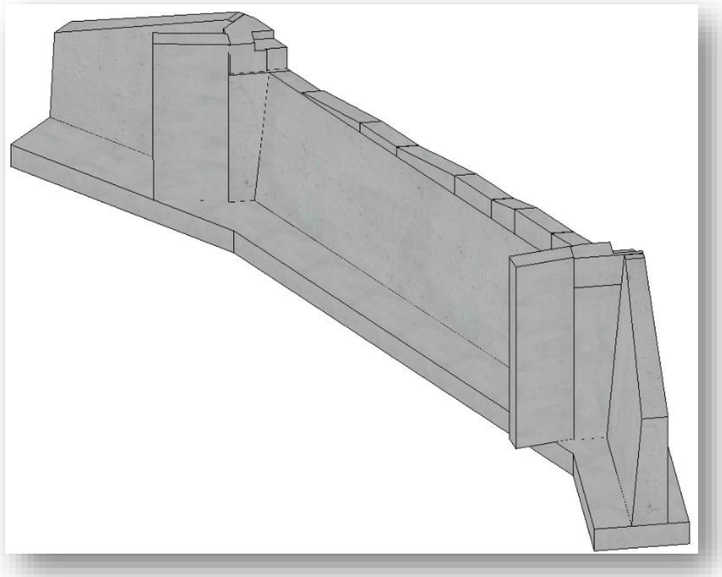
Modeling Criteria	Graphical Representation
H&H, TS&L D-2 criteria: Approximate size, shape, and length are provided to obtain size of hydraulic opening and horizontal clearances. I-1 criteria: General location and orientation are shown. No attributes are included. Foundations Submission D-2 criteria: Approximate dimensions are provided (similar to previous submission). Specific height required for correct bottom of footing elevation. I-2 criteria: Specific location and orientation are provided. Attributes may be shown as placeholders but are not required. Final Review of Plans D-3 criteria: Specific dimensions and reinforcement are provided. Construction joints, sealants and protective coatings may be provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications and pay items. Features such as rebar schedules and waterproofing details should be provided as supplemental information.	  **Example 1 - H&H, TS&L, and Foundation Submission Abutment Wall/Stem Elements**

FIGURE 24 - PIER CAP

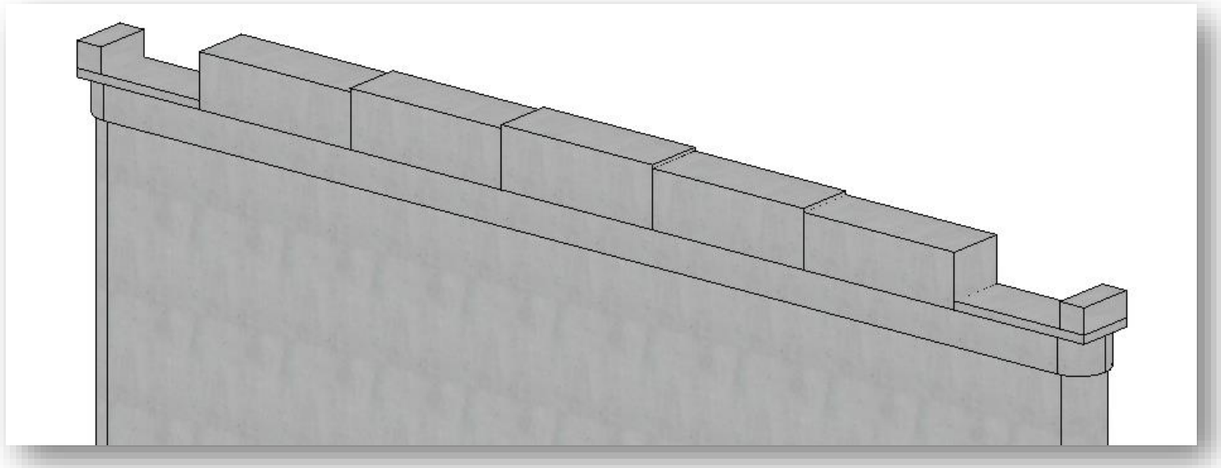
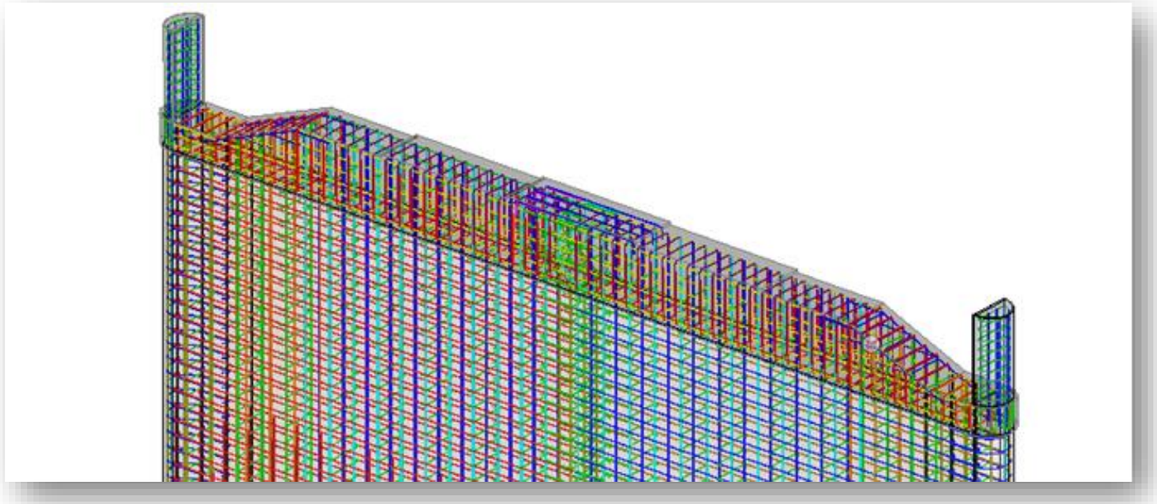
Modeling Criteria	Graphical Representation
H&H, TS&L D-2 criteria: Approximate size, shape, and length are provided to obtain size of hydraulic opening and horizontal clearances. I-1 criteria: General location and orientation are shown. No attributes are included. Foundations Submission D-2 criteria: Approximate dimensions are provided (similar to previous submission). Specific height required for correct bottom of footing elevation. I-2 criteria: Specific location and orientation are provided. Attributes may be shown as placeholders but are not required. Final Review of Plans D-3 criteria: Specific dimensions and reinforcement are provided. Construction joints, sealants and protective coatings may be provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications and pay items. Features such as rebar schedules and waterproofing details may be added as supplemental information.	 **Example 1– H&H, TS&L, & Foundation Submission Pier Cap Elements (wall pier cap)**  **Example 2 – Review of Plans and Final Plans Pier Cap Element**

FIGURE 25 - PIER WALL

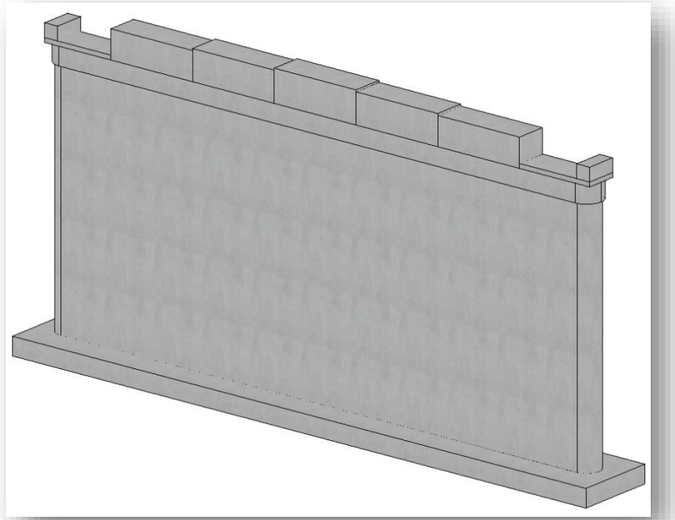
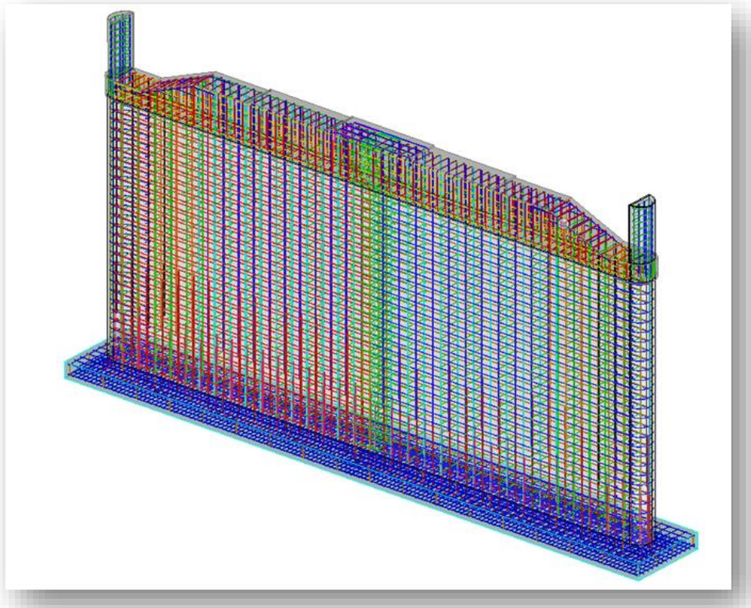
Modeling Criteria	Graphical Representation
H&H, TS&L D-2 criteria: Approximate size, shape, and length are provided to obtain size of hydraulic opening and horizontal clearances. I-1 criteria: General location and orientation are shown. No attributes are included. Foundations Submission D-2 criteria: Approximate dimensions are provided (similar to previous submission). Specific height required for correct bottom of footing elevation. I-2 criteria: Specific location and orientation are provided. Attributes may be shown as placeholders but are not required. Final Review of Plans D-3 criteria: Specific dimensions and reinforcement are provided. Construction joints, sealants and protective coatings may be provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications and pay items. Features such as rebar schedules and waterproofing details may be added as supplemental information.	 **Example 1– H&H, TS&L, & Foundation Submission Pier Wall Elements**  **Example 2 – Review of Plans and Final Plans Pier Wall Element**

FIGURE 26 - WINGWALL

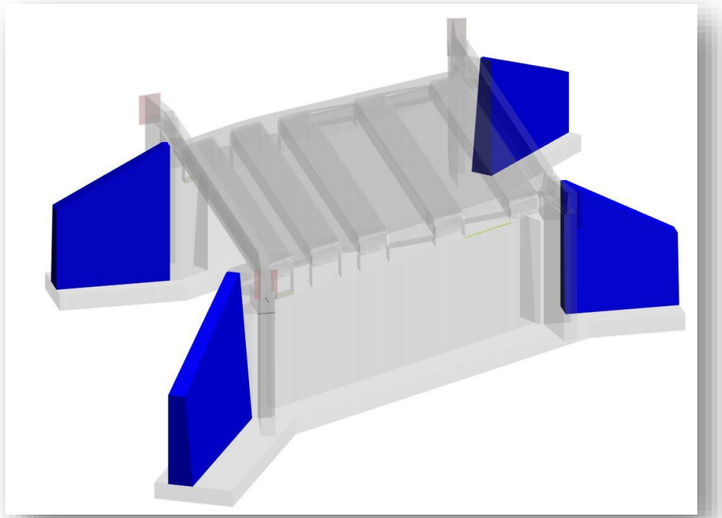
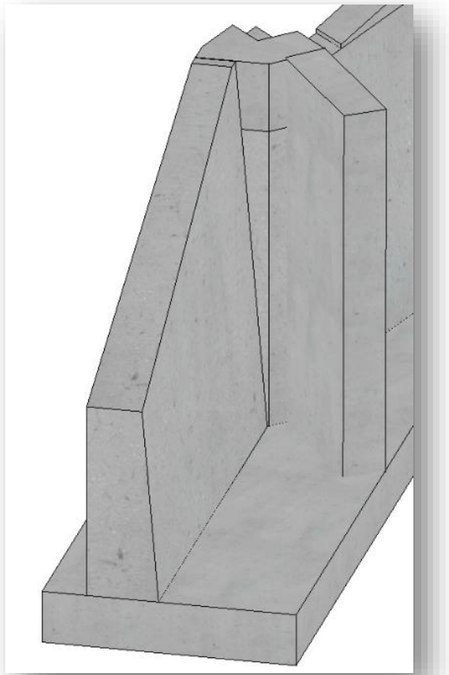
Modeling Criteria	Graphical Representation
H&H, TS&L D-2 criteria: Approximate size, shape, and length are provided. I-1 criteria: General location and specific orientation (U-shaped or flared) are shown. No attributes are included. Foundations Submission D-2 criteria: Approximate dimensions are provided (similar to previous submission). Specific height required for correct bottom of footing elevation. I-2 criteria: Specific location and orientation are provided. Attributes may be shown as placeholders but are not required. Final Review of Plans D-3 criteria: Specific dimensions and reinforcement are provided. Construction joints, sealants and protective coatings may be provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications and pay items. Features such as rebar schedules and waterproofing details may be added as supplemental information.	  **Example 1 – Wingwall Element for All Submittals (no change graphically, exact dimensions as required for separate submissions)**

FIGURE 27 - FOOTING/PILE CAP (INTEGRAL ABUTMENTS, BENTS, ETC.)

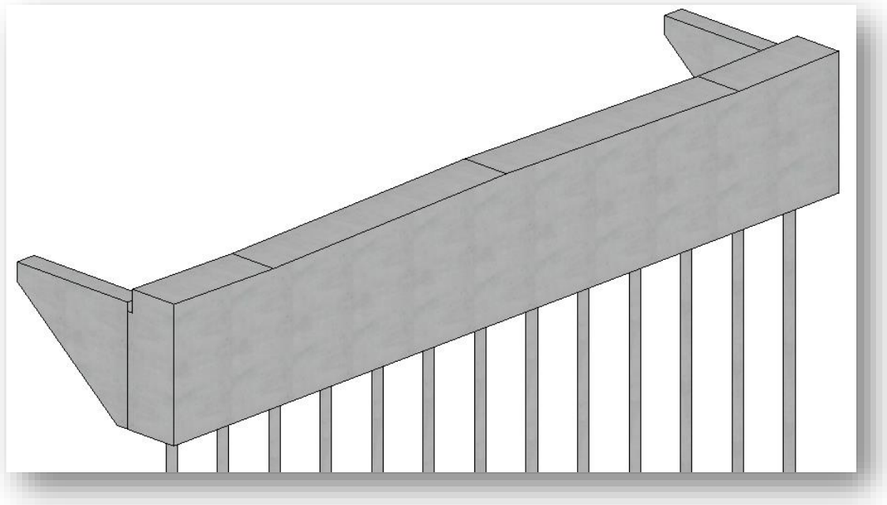
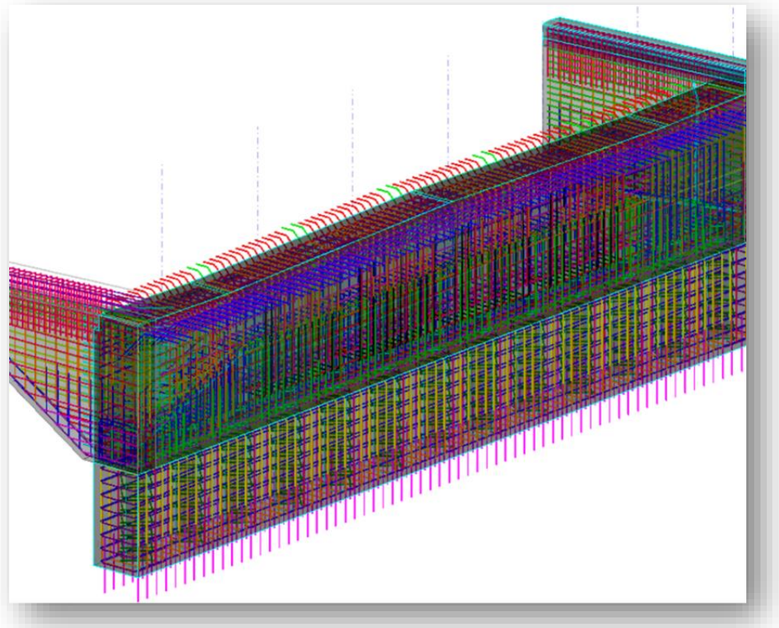
Modeling Criteria	Graphical Representation
H&H, TS&L D-2 criteria: Approximate size, shape, and length are provided to obtain size of hydraulic opening and horizontal clearances. I-1 criteria: General location and orientation are shown. No attributes are included. Foundations Submission D-2 criteria: Approximate dimensions are provided (similar to previous submission). Specific height required for correct bottom of footing elevation. I-2 criteria: Specific location and orientation are provided. Attributes may be shown as placeholders but are not required. Final Review of Plans D-3 criteria: Specific dimensions and reinforcement are provided. Construction joints, sealants and protective coatings may be provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications and pay items. Features such as rebar schedules and waterproofing details may be added as supplemental information.	 **Example 1 – H&H, TS&L, & Foundation Submission Footing/Pile Cap Elements (integral abutment)**  **Example 2 – Review of Plans and Final Plans Footing/Pile Cap Elements (integral abutment)**

FIGURE 28 - SPREAD FOOTING

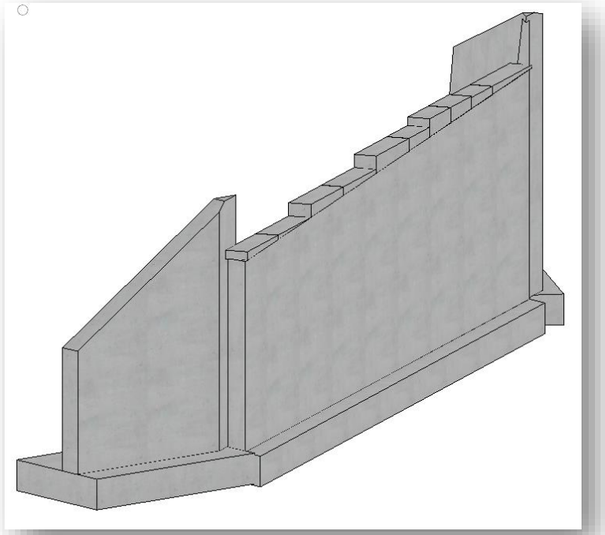
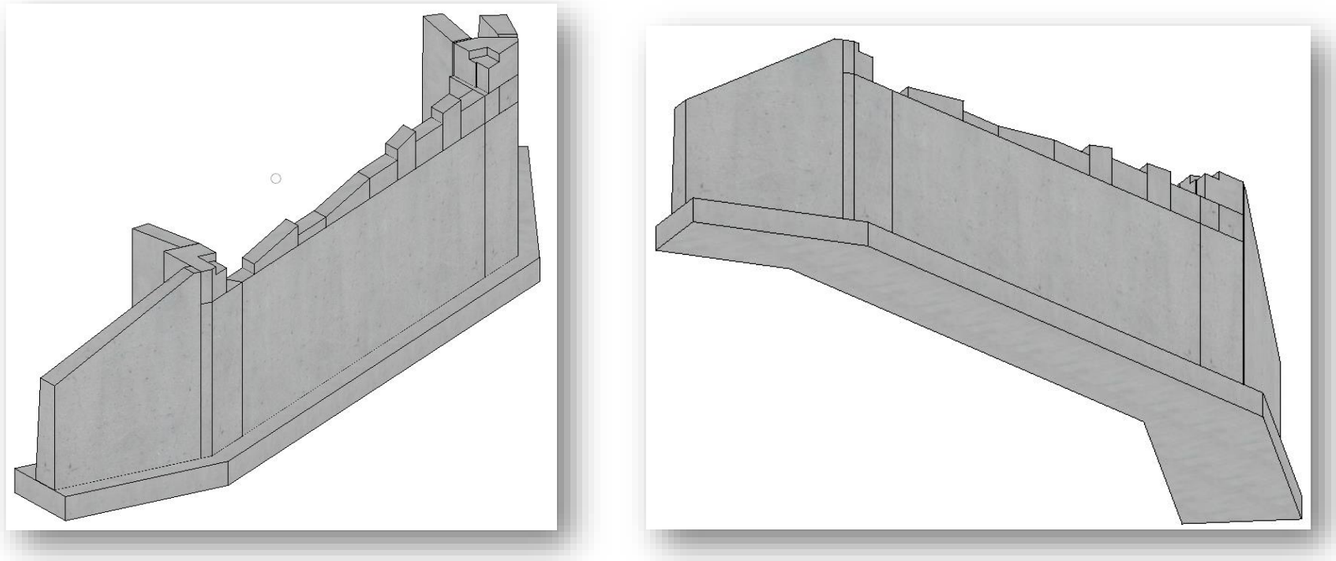
Modeling Criteria	Graphical Representation
H&H Not typically required TS&L D-1 criteria: General dimensions are provided. I-1 criteria: General location and orientation are provided. No attributes are included. Foundations Submission D-2 criteria: Approximate dimensions are provided. Specific depth required for correct bottom of footing elevation. I-2 criteria: Specific location and orientation are provided. Rock and/or soil data used to compute bearing resistances should be shown as an attribute. Other attributes may be shown as placeholders but are not required. Final Review of Plans D-3 criteria: Specific dimensions and reinforcement are provided. Construction joints, sealants and protective coatings may be provided as supplemental details. I-3 criteria: Includes attributes such as material properties, construction specifications, pay items, bearing pressures, lateral loads, and resistances. Features such as rebar schedules and waterproofing details should be provided as supplemental information.	 **Example 1–H&H, TS&L, and Foundation Submission Spread Footing Elements**  **Example 2 - Final Review of Plans and Final Plans Spread Footing Element (abutment)**

FIGURE 29 - BEARING SEATS/PEDESTALS

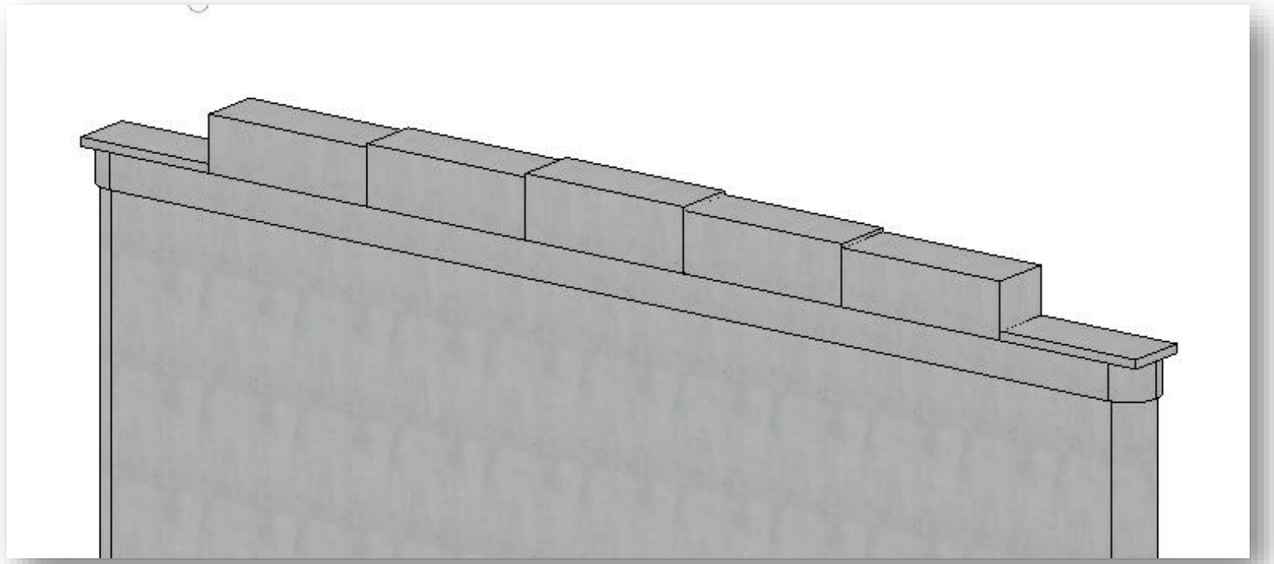
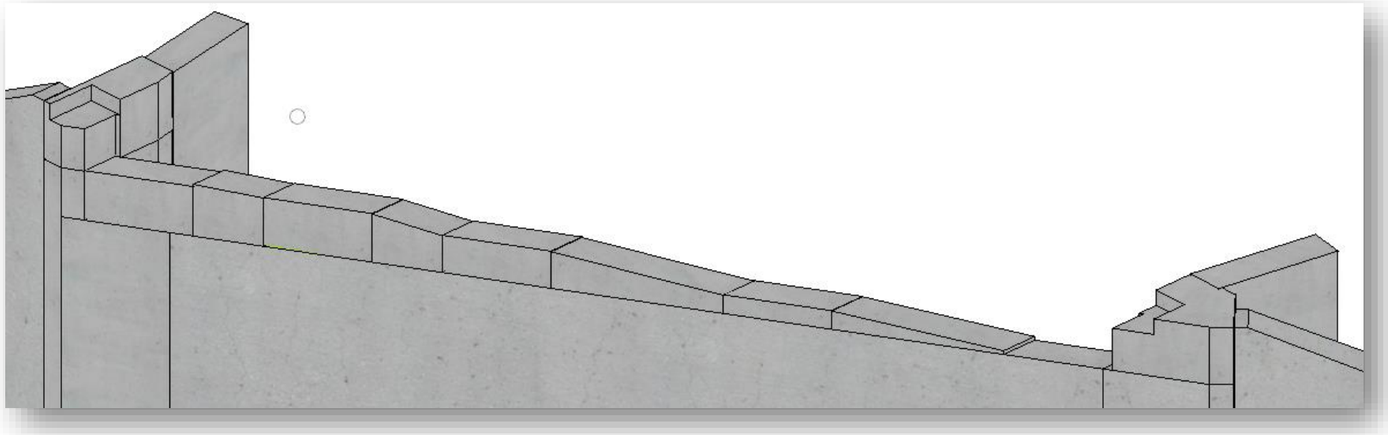
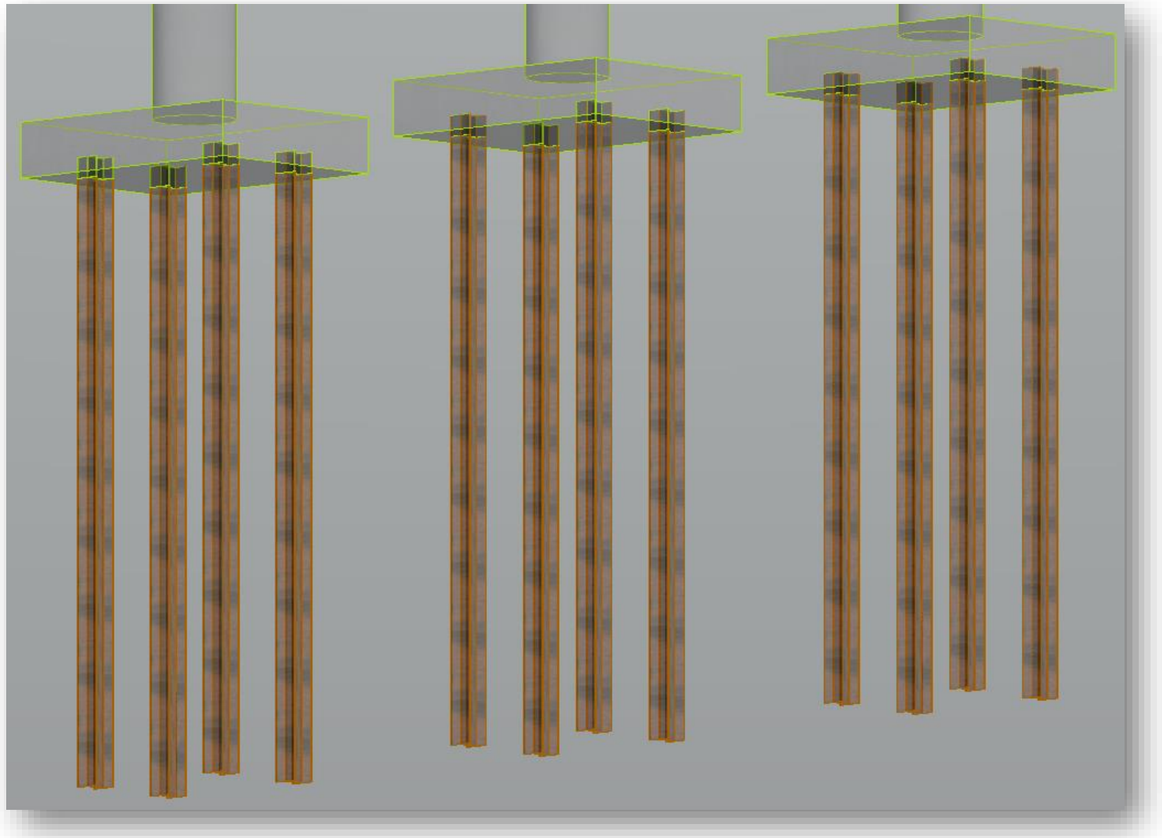
Modeling Criteria	Graphical Representation
H&H, TS&L, Foundations Submission D-2 criteria: Approximate size, shape, and length are provided to obtain size of hydraulic opening. I-1 criteria: General location and orientation are shown. No attributes are included. Final Review of Plans D-3 criteria: Specific dimensions and reinforcement are provided. Pedestal may be combined with Pier Cap or Pier Wall elements. Construction joints, sealants and protective coatings may be provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications and pay items. Features such as rebar schedules and waterproofing details may be added as supplemental information.	 **Example 1 - H&H, TS&L, & Foundation Submission Bearing Seat Elements (wall pier)**  **Example 2 – Review of Plans and Final Plans Bearing Seat Element**

FIGURE 30 - STEEL PILE

Modeling Criteria	Graphical Representation
H&H Not typically required for hydraulic analysis TS&L D-1 criteria: General dimensions shown. I-1 criteria: General location, spacing and type shown. No attributes are provided. Foundations Submission D-2 criteria: Approximate dimensions shown. Length shown to approximate tip elevation. I-2 criteria: Approximate number, spacing, pile type, and tip reinforcement noted as attributes. Rock and/or soil data used to compute resistances and driving method should be included. Final Review of Plans D-3 criteria: Specific steel shape is provided. Pile tip reinforcement and splices are provided as supplemental details. I-3 criteria: Includes attributes such as type, material properties, construction specifications, pay items, loads and resistances. Features such as foundation notes and connection details may be added as supplemental information.	

Example 1 - Steel Pile Element (all submissions with specific dimensions provided as required)

Table 6. Drainage Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Inlets													
Grate Inlet	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 31 - Frames, Covers, and Inlets
Inlet Box	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Slotted Drain	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Spring Box	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Apron	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Manholes and Junction Boxes													
Manhole	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 32 - Manholes, and Junction Boxes
Junction Box	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Headwalls and End Walls													
End Section	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 33 - Headwall, End walls, and End Sections
End Wall	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Wingwall	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
End Transition	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Flared End Transition	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Cross Sections													
Inlet Section	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Outlet Section	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Outlet Structure	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Energy Dissipater	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	Figure 34 - Rock Apron and Energy Dissipator
Pipes and Culverts													
Box Culvert	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Culvert	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	Figure 35 - Culvert and Pipe
Pipe	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	

Miscellaneous													
Cross Pan	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Swales	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Pond	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	3D	D-3	I-3	3D	
Conveyance Channel	D-1	I-1	2D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 36 - Conveyance Channel
Stream Relocation (Permanent)	D-1	I-1	2D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 37 - Stream Relocation (Permanent)

FIGURE 31 - FRAMES, COVERS, AND INLETS

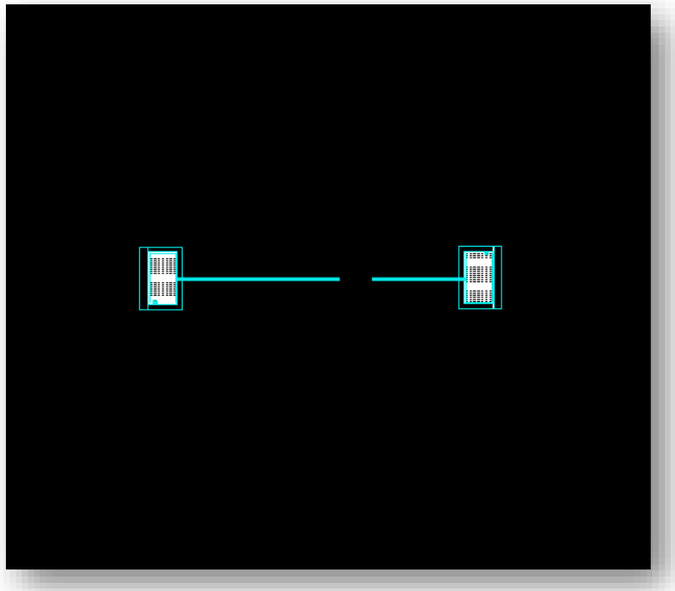
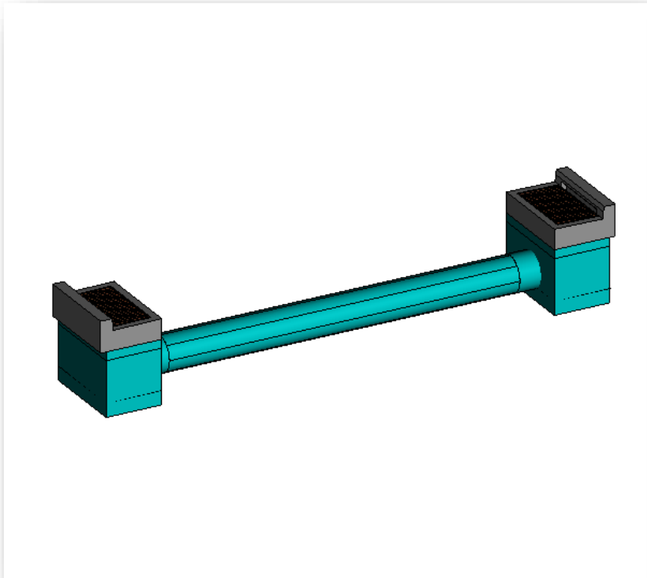
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: General location of inlets at sag points, intersections, crosswalks, bridges, cross slope reversals, and other strategic locations not based on drainage area size. Pipes connected to inlets to create a network of storm sewers. I-1 criteria: Attributes for inlet top of grate elevation, outlet pipe elevation, and pipe size. 3D Representation: Use feature definition with 3D solid for inlet and pipe Design Field View (DFV) D-2 criteria: Approximate final location inlets at strategic locations, inlets based on gutter spread criteria, and flanking inlets at sag points. Pipes connected to inlets to create a network of storm sewers. I-2 criteria: Attributes for inlet size, top of grate elevation, bottom of box elevation, outlet pipe elevation, pipe material, shape, and size. 3D Representation: Use feature definition with 3D solid for inlet and pipe Final Design Office Meeting (FDOM) D-3 criteria: Final location of all inlets at all strategic locations and where required by spread and sag criteria. Display inlet top unit type and grate type. Pipes connected to inlets to create a network of storm sewers. I-3 criteria: Attributes for inlet box size and depth, inlet top unit type, top of grate elevation, grate type, bottom of box elevation, outlet pipe elevation, pipe material, roughness, shape, and size. Attach ECMS item attributes. 3D Representation: Use feature definition with 3D solid for inlet and pipe Plan/Specifications and Estimate (PS&E) D-3 criteria: Final location of all inlets at all strategic locations and where required by spread and sag criteria. Display inlet top unit type and grate type. Pipes connected to inlets to create a network of storm sewers. I-3 criteria: Attributes for inlet box size and depth, inlet top unit type, top of grate elevation, grate type, bottom of box elevation, outlet pipe elevation, pipe material, roughness, shape, and size. 3D Representation: Use feature definition with 3D solid for inlet and pipe	 **Example 1 – 2D Representation**  **Example 2 – 3D Representative**

FIGURE 32 - MANHOLES, AND JUNCTION BOXES

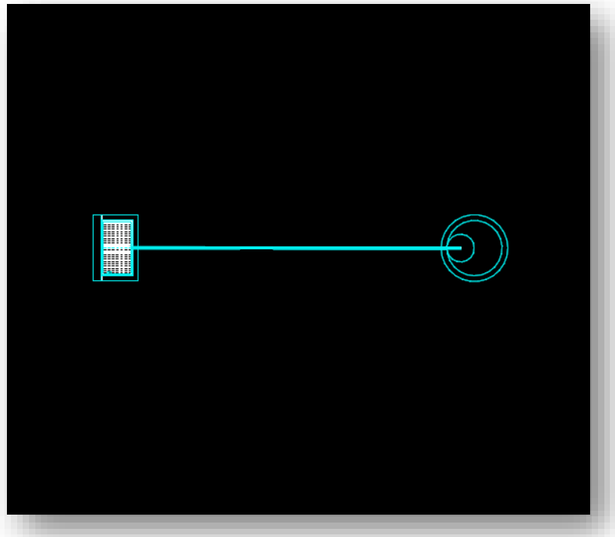
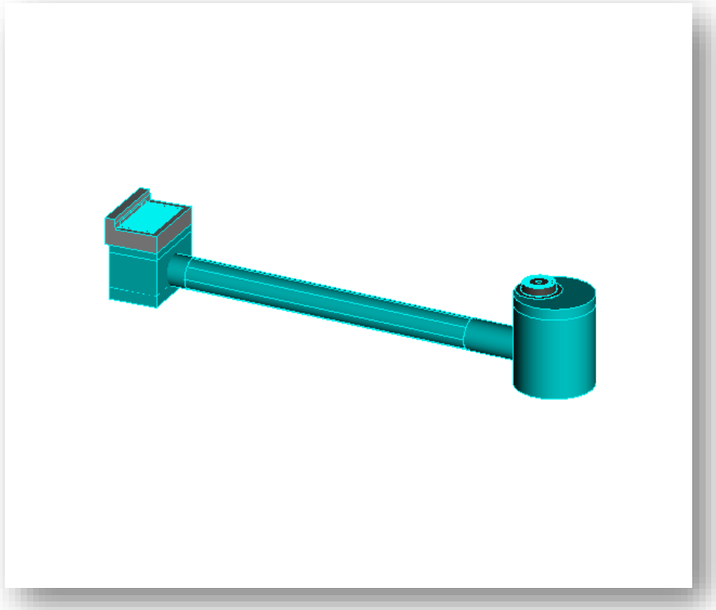
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: General location of manhole connected to storm sewer network at junction points. I-1 criteria: Attributes for rim elevation and invert elevations of connecting pipes. 3D Representation: Use feature definition with 3D solid for manhole. Design Field View (DFV) D-2 criteria: Approximate final location of manhole connected to storm sewer network at junction points. Display manhole size based on orientation of connected pipes. I-2 criteria: Attributes for manhole size, rim elevation and invert elevations of connecting pipes. 3D Representation: Use feature definition with 3D solid for manhole. Final Design Office Meeting (FDOM) D-3 criteria: Final location of manhole connected to storm sewer network at junction points. Display manhole size based on orientation of connected pipes and manhole cover location. I-3 criteria: Attributes for manhole size and depth, rim elevation, bottom of structure elevation, and invert elevations of connecting pipes. Attach ECMS item attributes. 3D Representation: Use feature definition with 3D solid for manhole. Plan/Specifications and Estimate (PS&E) D-3 criteria: Final location of manhole connected to storm sewer network at junction points. Display manhole size based on orientation of connected pipes and manhole cover location. I-3 criteria: Attributes for manhole size and depth, rim elevation, bottom of structure elevation, and invert elevations of connecting pipes. 3D Representation: Use feature definition with 3D solid for manhole.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 33 - HEADWALL, END WALLS, AND END SECTIONS

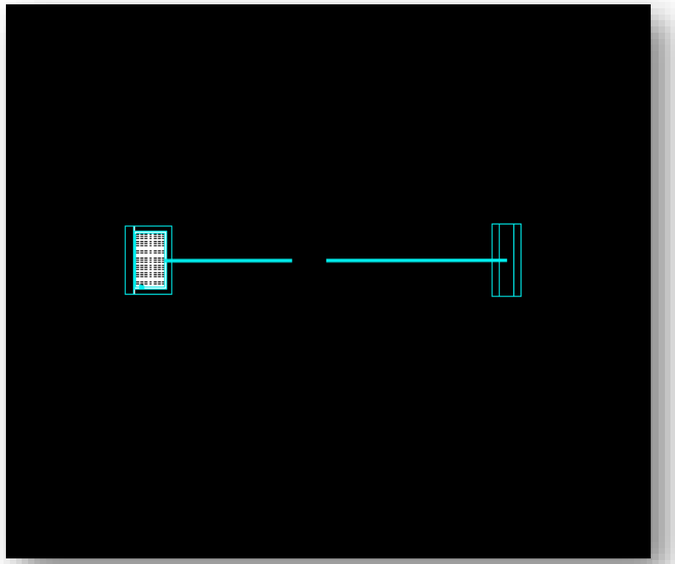
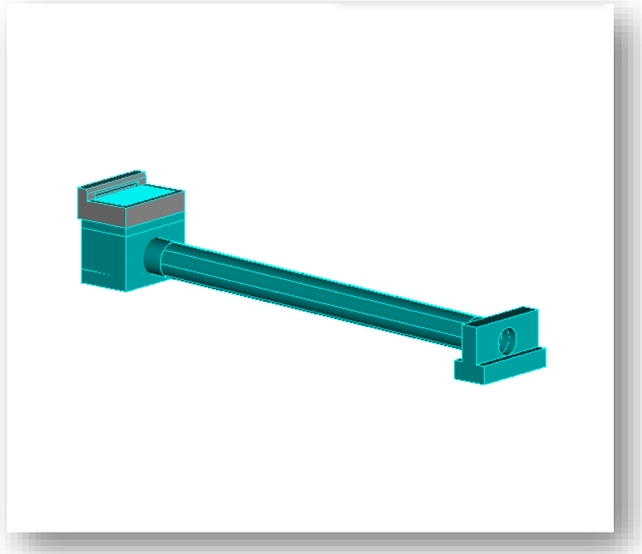
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: General location of pipe and end wall, Pipe connected to end section at outlet of storm sewer network. I-1 criteria: Attributes for invert elevation and size. 3D Representation: Use feature definition with 3D solid for end wall. Design Field View (DFV) D-2 criteria: Approximate final location of pipe and end wall. Pipe connected to end section at outlet of storm sewer network. I-2 criteria: Attributes for invert elevation and size. 3D Representation: Use feature definition with 3D solid for end wall. Final Design Office Meeting (FDOM) D-3 criteria: Final location of pipe and end wall. Pipe connected to end section at outlet of storm sewer network. Matches outlet elevation of stream or channel surface I-3 criteria: Attributes for invert out elevation, end wall type, and size. Attach ECMS item attributes. 3D Representation: Use feature definition with 3D solid for end wall. Plan/Specifications and Estimate (PS&E) D-3 criteria: Final location of pipe and end wall. Pipe connected to end section at outlet of storm sewer network. Matches outlet elevation of stream or channel surface I-3 criteria: Attributes for invert out elevation, end wall type, and size. 3D Representation: Use feature definition with 3D solid for end wall.	 **Example 1 – 2D Representation**  **Example 2 – 3D Representation**

FIGURE 34 - ROCK APRON AND ENERGY DISSIPATOR

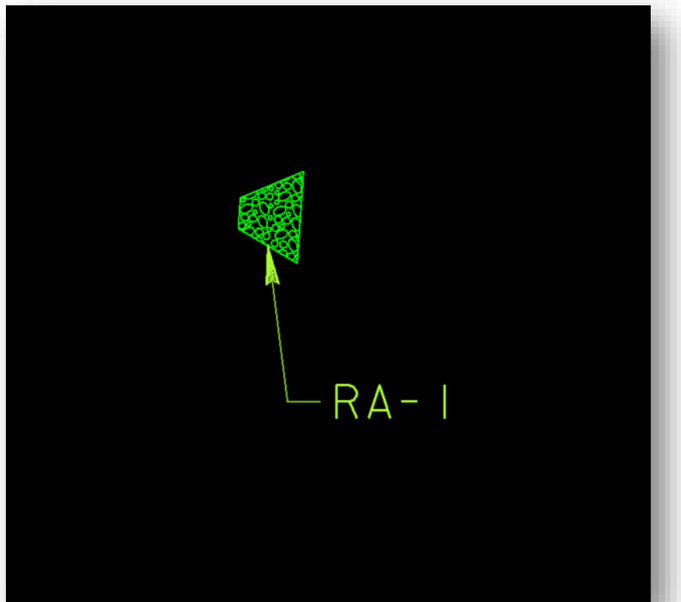
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: none I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard rock apron or energy dissipator cell. Full size per calculations to fit within ROW I-2 criteria: Attributes for baseline, station, and offset. 3D Representation: none Final Design Office Meeting (FDOM) D-3 criteria: Standard rock apron or energy dissipator cell. Full size per calculations to fit within ROW I-3 criteria: Attributes for baseline, station, offset, apron length, apron initial width, apron final width, material, and depth. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard rock apron or energy dissipator cell. Full size per calculations to fit within ROW I-3 criteria: Attributes for baseline, station, offset, apron length, apron initial width, apron final width, material, and depth. Attach ECMS item attributes. 3D Representation: none	 **Example 1 – 2D Representation**

FIGURE 35 - CULVERT AND PIPE

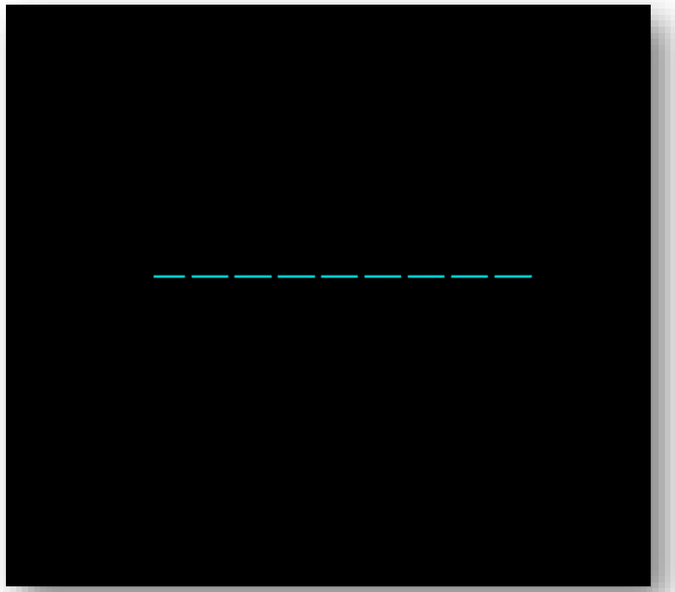
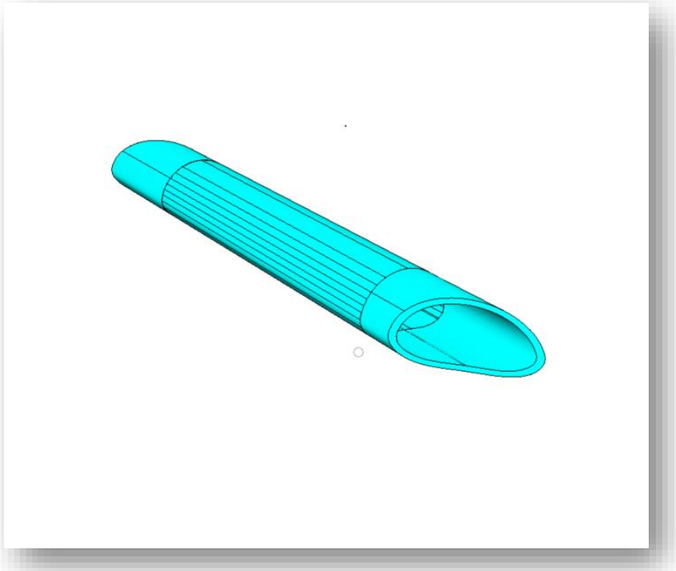
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Single line for preliminary general location of culvert or pipe. I-1 criteria: None 3D Representation: 2D representation Design Field View (DFV) D-2 criteria: Single line for general location of culvert or pipe. I-2 criteria: Attributes for pipe/culvert size, shape, invert elevations, and slope. 3D Representation: Use feature definition with 3D solid for pipe/culvert Final Design Office Meeting (FDOM) D-3 criteria: Single line for final location of culvert or pipe. I-3 criteria: Attributes for pipe/culvert size, shape, material, roughness, invert elevations, and slope. Attach ECMS item attributes. 3D Representation: Use feature definition with 3D solid for pipe/culvert Plan/Specifications and Estimate (PS&E) D-3 criteria: Single line for final location of culvert or pipe. I-3 criteria: Attributes for pipe/culvert size, shape, material, roughness, invert elevations, and slope. Attach ECMS item attributes. 3D Representation: Use feature definition with 3D solid for pipe/culvert	 **Example 1 – 2D Representation**  **Example 2 – 3D Representation**

FIGURE 36 - CONVEYANCE CHANNEL

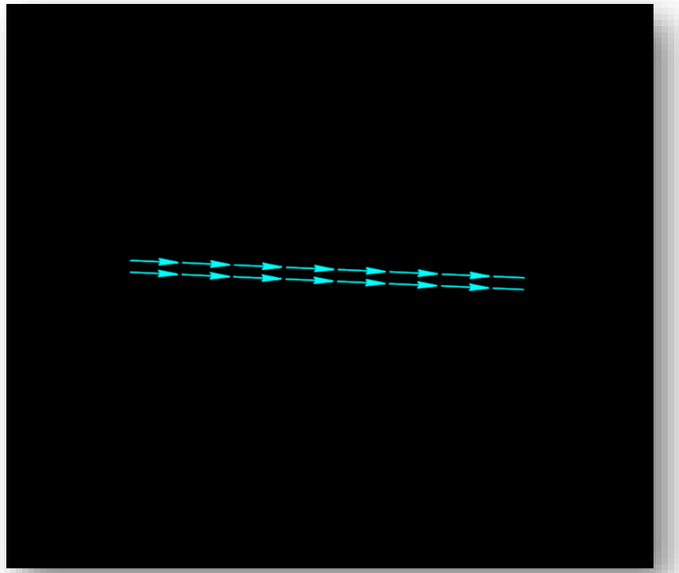
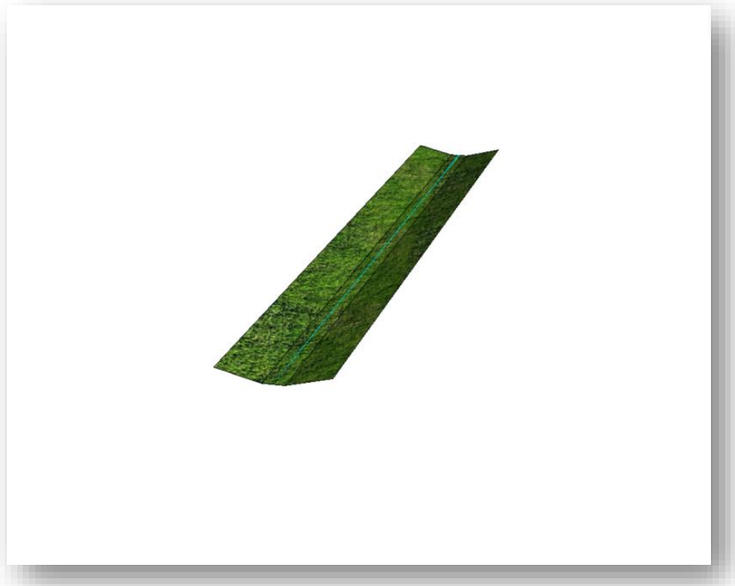
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Single line for channel centerline. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-2 criteria: Attributes for channel inverts and slope. 3D Representation: Graded bottom and side slopes. Final Design Office Meeting (FDOM) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, and lining roughness. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes. Plan/Specifications and Estimate (PS&E) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, and lining roughness. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes.	 **Example 1 – 2D Representation**  **Example 2 – 3D Representation**

FIGURE 37 - STREAM RELOCATION (PERMANENT)

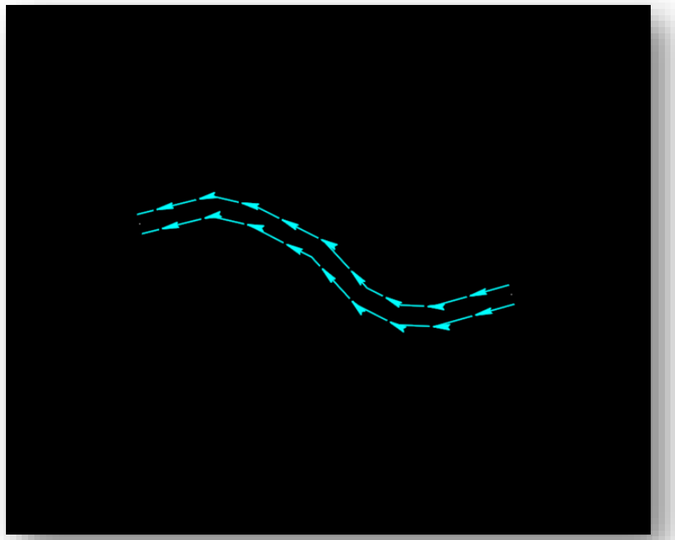
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Single line for channel centerline. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-2 criteria: Attributes for channel inverts and slope. 3D Representation: Graded bottom and side slopes. Final Design Office Meeting (FDOM) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, lining roughness, check dam height, check dam spacing, planting media depth. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes. Planting media component. Rock lining depth (if applicable). Check dams. Plan/Specifications and Estimate (PS&E) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, lining roughness, check dam height, check dam spacing, planting media depth. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes. Planting media component. Rock lining depth (if applicable). Check dams.	 **Example 1 – 2D Representation**  **Example 2 – 3D Representation**

Table 7. ESPC and PCSM Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representations
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Erosion Control Measures													
Rock Construction Entrances	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 38 - Rock Construction Entrance
Compost Filter Sock/Silt Fence	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 39 - Compost Filter Sock and Silt Fence
Earth Berm/Water bar	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 40 - Earth Berm and Water Bar
Pumped Water Filter Bag	N/R	N/R	N/R	D-2	I-1	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 41 - Pumped Water Filter Bag
Rock Filters	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 42 - Rock Filter
Rolled Erosion Control Products	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 43 - Rolled Erosion Control Products
Sediment Traps	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 44 - Sediment Traps, Sediment Basins, Compost Filter Sock Traps
Sediment Basins	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Composite Filter Sock Traps	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Inlet Protection	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 45 - Inlet Protection and Temporary Inlet Caps
Temporary Inlet Caps	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Temporary Protective Fence	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 46 - Temporary Protective Fence
Concrete Washout	N/R	N/R	N/R	D-2	I-1	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 47 - Concrete Washout
Berm, Slope Drain, and Pipes													
Bypass Pipe	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 48 - Bypass Pipe and Slope Pipe
Slope Pipe	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Stream Diversion	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Temporary Rock Apron	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 49 - Temporary Rock Apron
Temporary Channels (Diversion, Collection, Conveyance)	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 50 - Temporary Channels (Diversion, Collection, Conveyance)
Temporary Stream Crossing	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 51 - Temporary Stream Crossing
Temporary Cofferdam	N/R	N/R	N/R	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 52 - Temporary Cofferdam
PCSM													

Stormwater Pond	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 53 - Stormwater Pond/Rain Garden
Rain Gardens	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Underground detention systems/subsurface storage	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 54 - Underground Detention System/Subsurface Storage
Vegetated Channel (Permanent)	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 55 - Vegetated Channel (Permanent)
Amended Soils/Planting Soils/Tree Pits	N/R	N/R	N/R	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 56 - Amended Soils/Planting Soils/Tree Pits
Waterbodies and Wetlands	N/R	N/R	N/R	D-2	I-1	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 57 - Waterbodies and Wetlands
Regulatory Boundaries	N/R	N/R	N/R	D-2	I-1	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 58 - Regulatory Boundaries

FIGURE 38 - ROCK CONSTRUCTION ENTRANCE

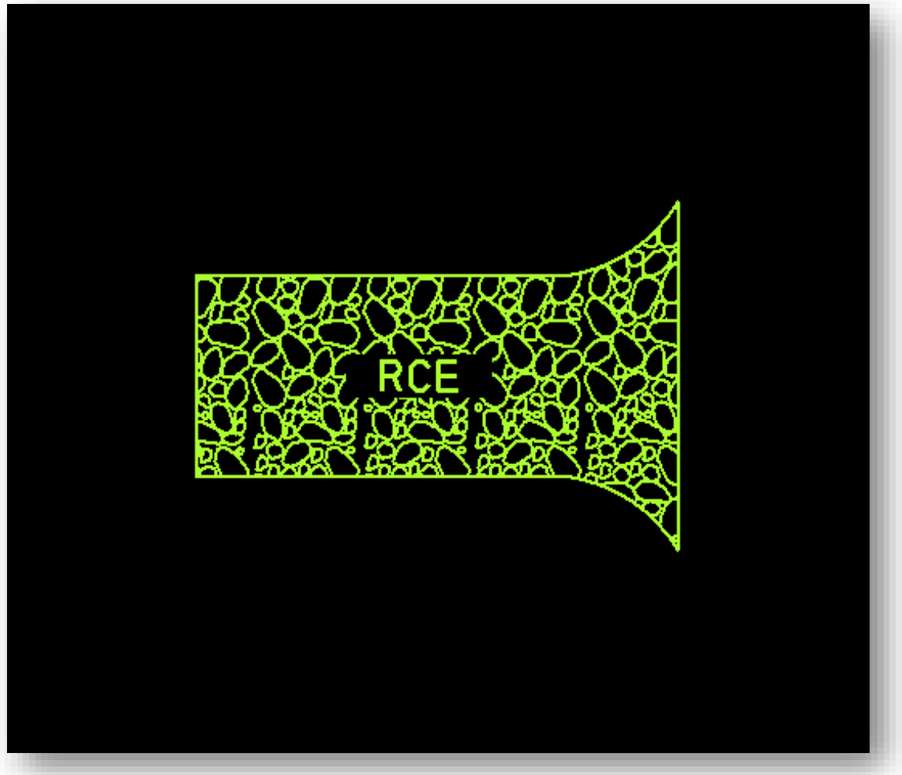
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard cell or custom shape using pattern meeting minimum dimensions from RC-77M I-2 criteria: Attributes for baseline, station, offset and stage. 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard cell or custom shape using pattern meeting minimum dimensions from RC-77M I-3 criteria: Attributes for baseline, station, offset and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard cell or custom shape using pattern meeting minimum dimensions from RC-77M I-3 criteria: Attributes for baseline, station, offset and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 39 - COMPOST FILTER SOCK AND SILT FENCE

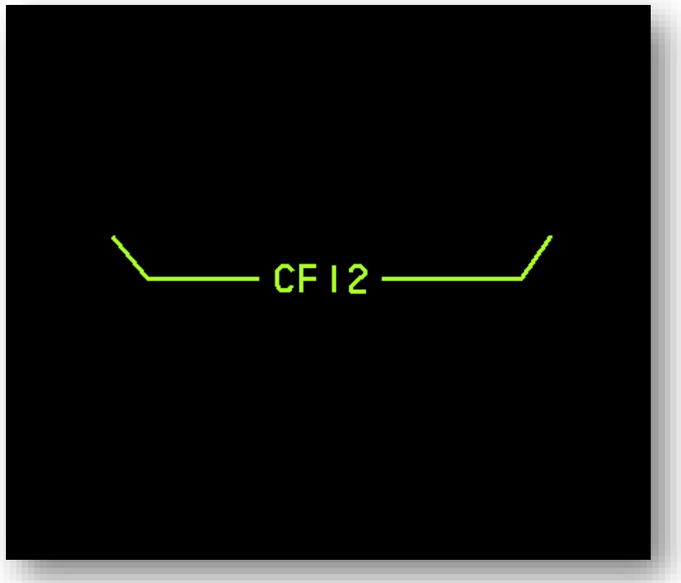
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Polyline with line type specific to sediment barrier type. For compost filter sock, line type specific to sock size. I-2 criteria: Attributes for size, baseline, station, offset and stage. 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Polyline with line type specific to sediment barrier type. For compost filter sock, line type specific to sock size. I-3 criteria: Attributes for size, baseline, station, offset, and stage. For sediment barriers, include upstream slope, slope length. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Polyline with line type specific to sediment barrier type. For compost filter sock, line type specific to sock size. I-3 criteria: Attributes for size, baseline, station, offset, and stage. For sediment barriers, include upstream slope, slope length. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 40 - EARTH BERM AND WATER BAR

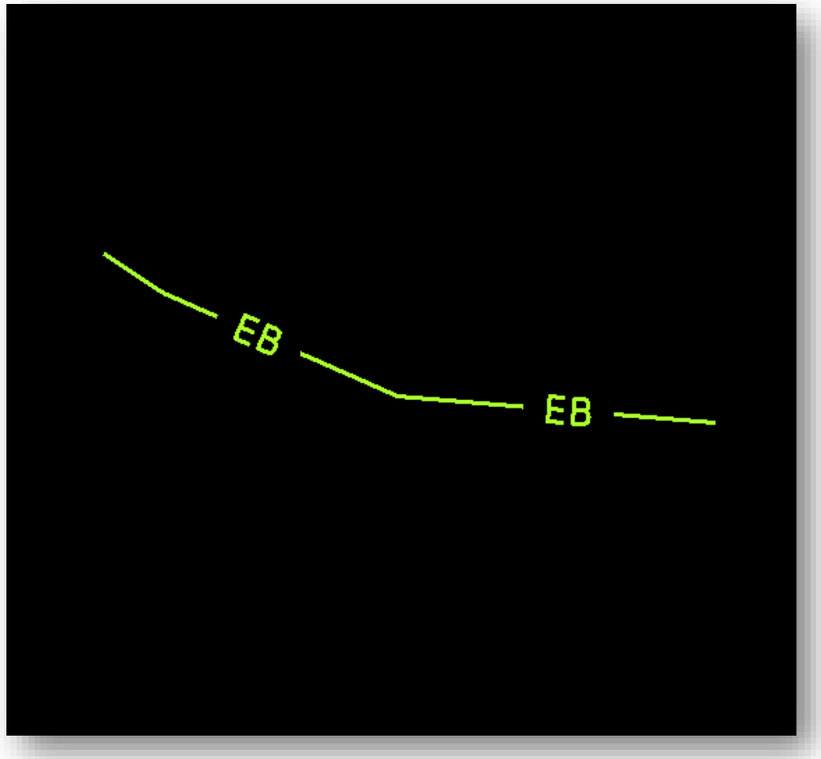
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Polyline with linetype specific to berm type. I-2 criteria: Attributes for size, baseline, station, offset and stage. 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Polyline with linetype specific to berm type. I-3 criteria: Attributes for size, baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Polyline with linetype specific to berm type. I-3 criteria: Attributes for size, baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 41 - PUMPED WATER FILTER BAG

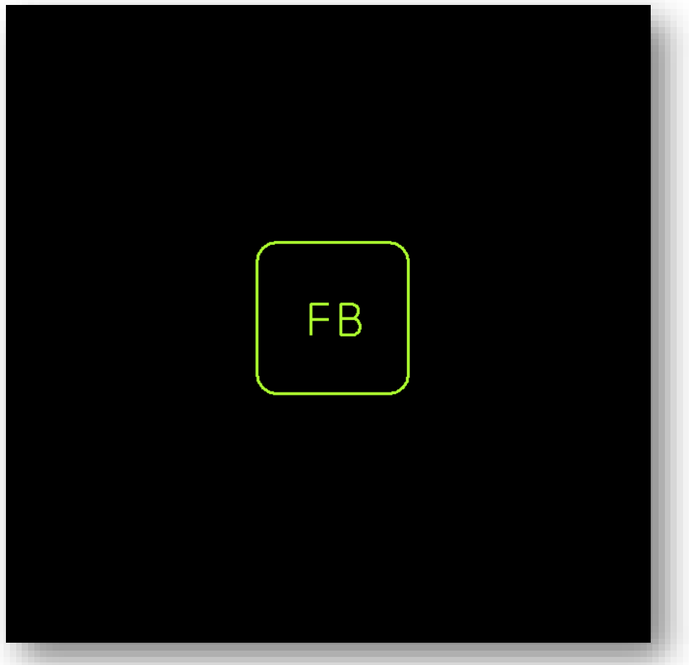
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard cell I-1 criteria: none 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard cell I-3 criteria: Attributes for baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard cell I-3 criteria: Attributes for baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 42 - ROCK FILTER

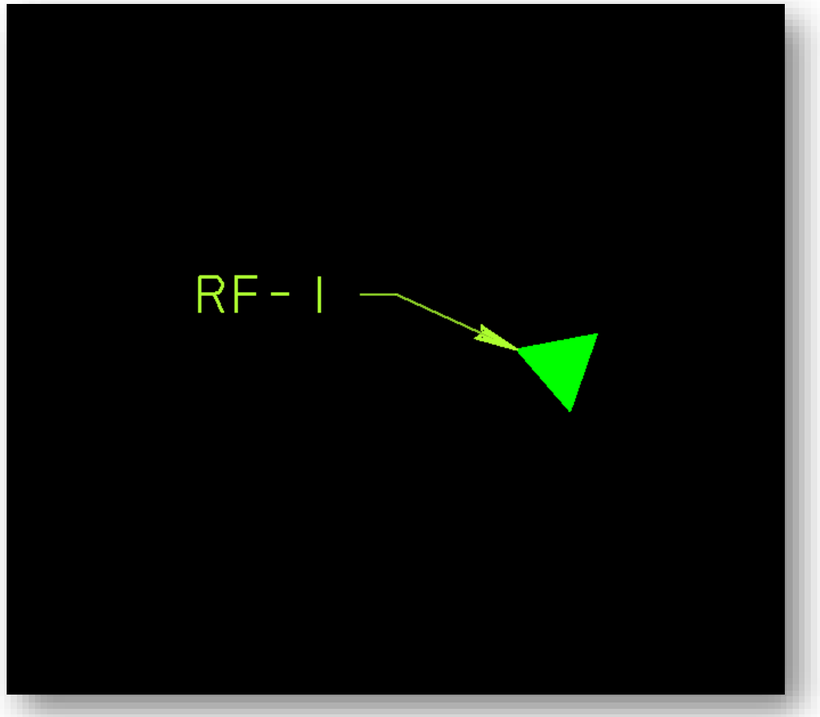
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard cell. I-2 criteria: Attributes for baseline, station, offset and stage. 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard cell. I-3 criteria: Attributes for channel depth, riprap size, baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard cell. I-3 criteria: Attributes for channel depth, riprap size, baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 43 - ROLLED EROSION CONTROL PRODUCTS

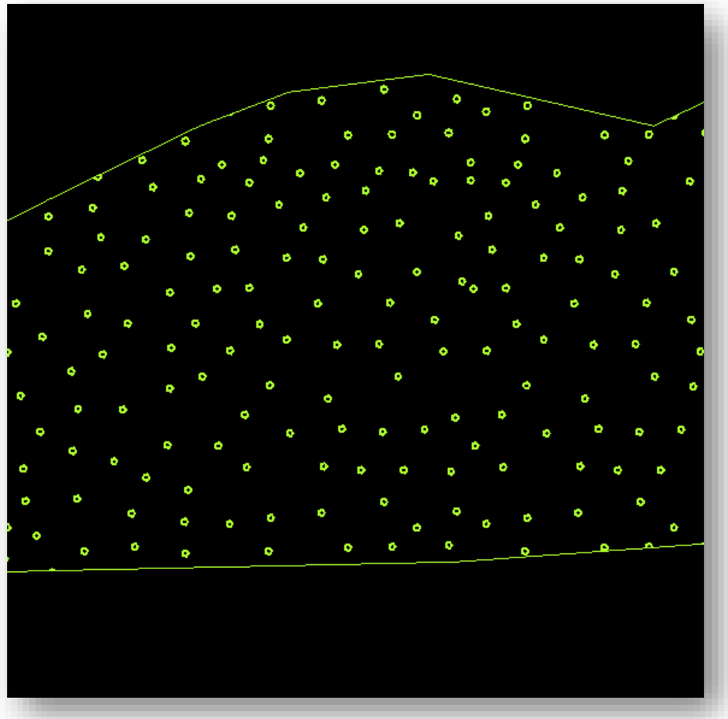
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard pattern fill for area requiring lining. I-2 criteria: Attributes for material type. 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard pattern fill for area requiring lining. I-3 criteria: Attributes for material type, area, and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard pattern fill for area requiring lining. I-3 criteria: Attributes for material type, area, and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 44 - SEDIMENT TRAPS, SEDIMENT BASINS, COMPOST FILTER SOCK TRAPS

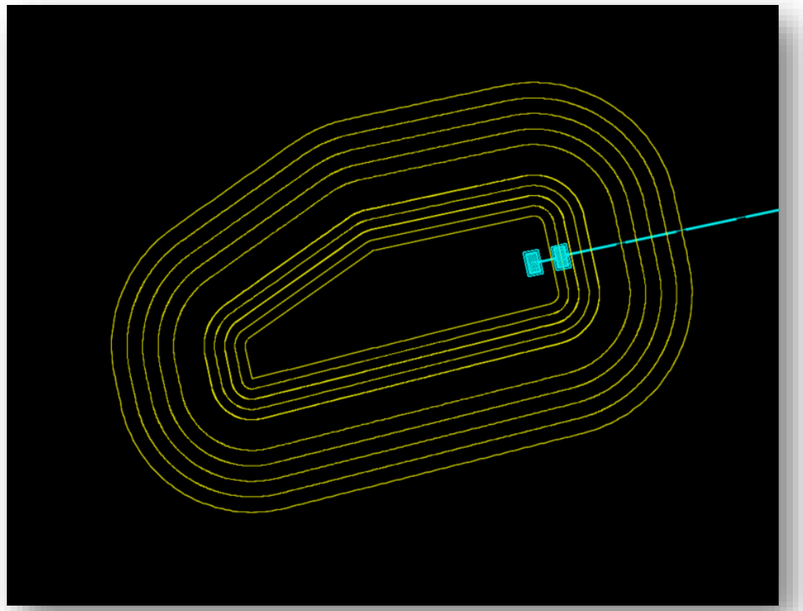
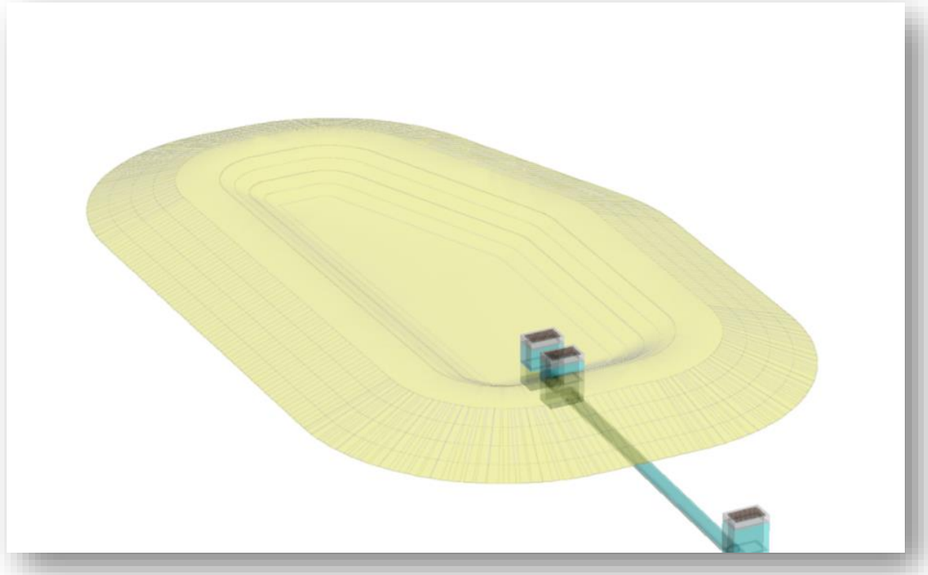
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Basin grading displayed with contours in plan. Outlet structure and outlet pipe shown. I-2 criteria: Attributes for BMP ID, type, and storage volume. 3D Representation: Grading for basin/rain garden berm, side slopes, and bottom. Outlet structure & outlet pipes. Final Design Office Meeting (FDOM) D-3 criteria: Basin grading displayed with contours in plan. Outlet structure, outlet pipe, and underdrain layout shown. I-3 criteria: Attributes for BMP ID, type, storage volume, outlet structure orifice sizes, media/aggregate layer void ratios. Attach ECMS item attributes. 3D Representation: Grading for basin/rain garden berm, side slopes, bottom, and emergency spillway. Soil and aggregate layers. Underdrain network with wyes and cleanouts. Outlet structure with orifices detailed, outlet pipes, anti-seep collars. Plan/Specifications and Estimate (PS&E) D-3 criteria: Basin grading displayed with contours in plan. Outlet structure, outlet pipe, and underdrain layout shown. I-3 criteria: Attributes for BMP ID, type, storage volume, outlet structure orifice sizes, media/aggregate layer void ratios. Attach ECMS item attributes. 3D Representation: Grading for basin/rain garden berm, side slopes, bottom, and emergency spillway. Soil and aggregate layers. Underdrain network with wyes and cleanouts. Outlet structure with orifices detailed, outlet pipes, anti-seep collars.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 45 - INLET PROTECTION AND TEMPORARY INLET CAPS

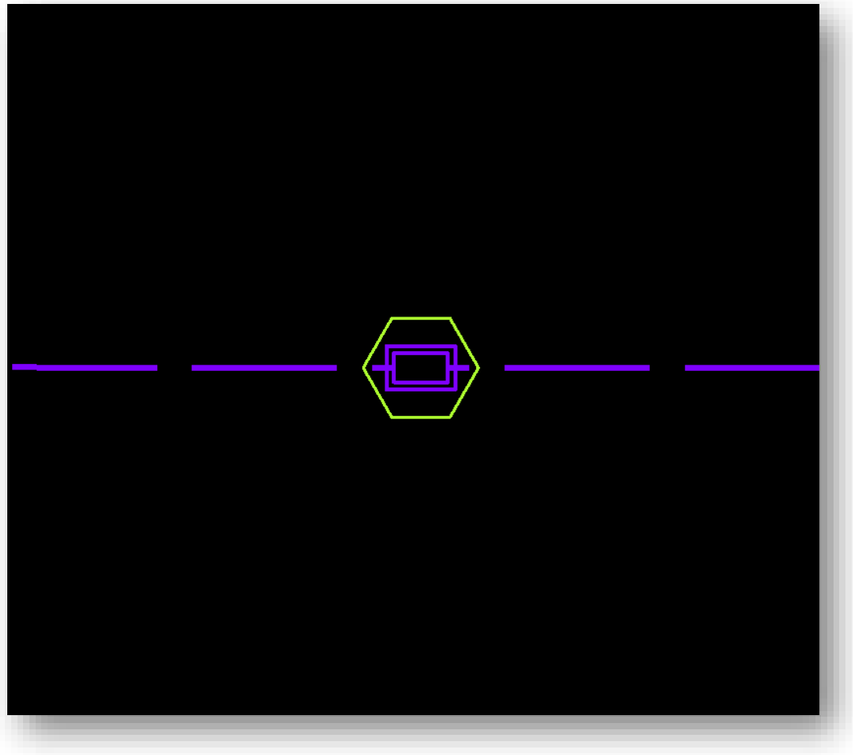
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard cell placed on top of inlet in plan view. I-2 criteria: Attributes for inlet id, type of inlet protection, baseline, station, offset and stage. 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard cell placed on top of inlet in plan view. I-3 criteria: Attributes for inlet id, type of inlet protection, baseline, station, offset and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard cell placed on top of inlet in plan view. I-3 criteria: Attributes for inlet id, type of inlet protection, baseline, station, offset and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 46 - TEMPORARY PROTECTIVE FENCE

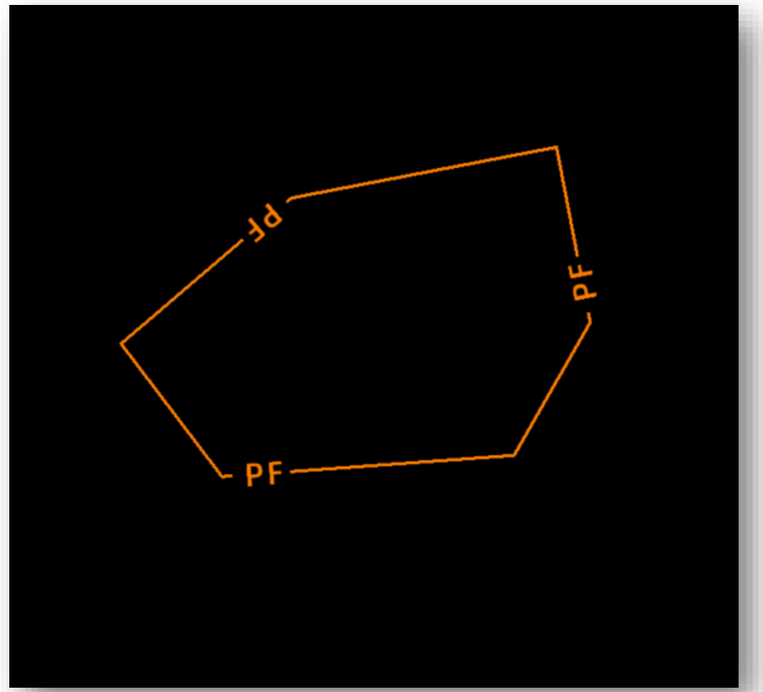
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard linetype I-2 criteria: Attributes for length and stage 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard linetype I-3 criteria: Attributes for length and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard linetype I-3 criteria: Attributes for length and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 47 - CONCRETE WASHOUT

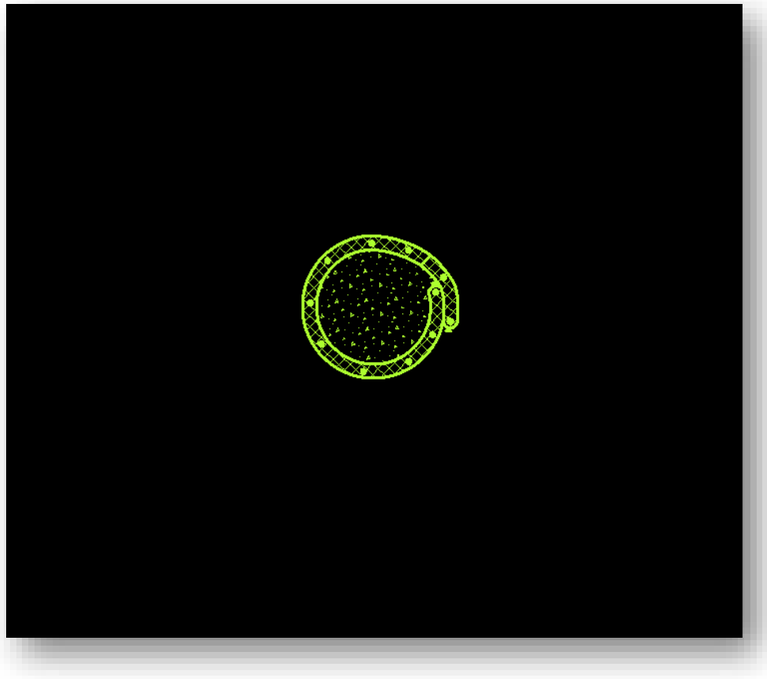
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard cell I-1 criteria: none 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard cell I-3 criteria: Attributes for baseline, station, offset, and stage. No ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard cell I-3 criteria: Attributes for baseline, station, offset, and stage. No ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 48 - BYPASS PIPE AND SLOPE PIPE

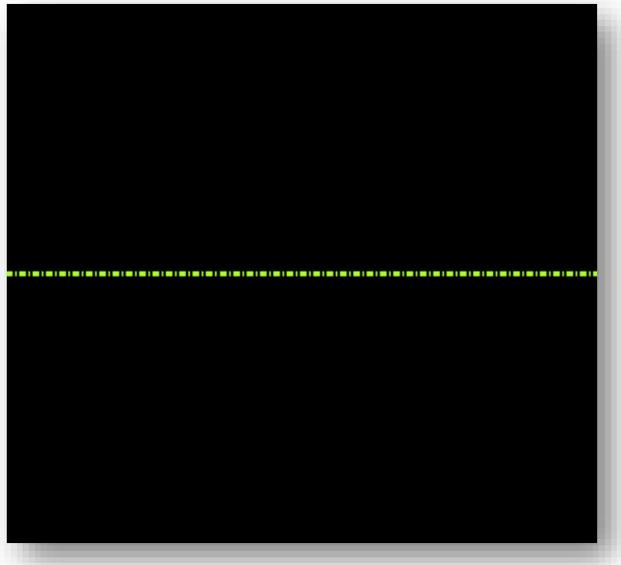
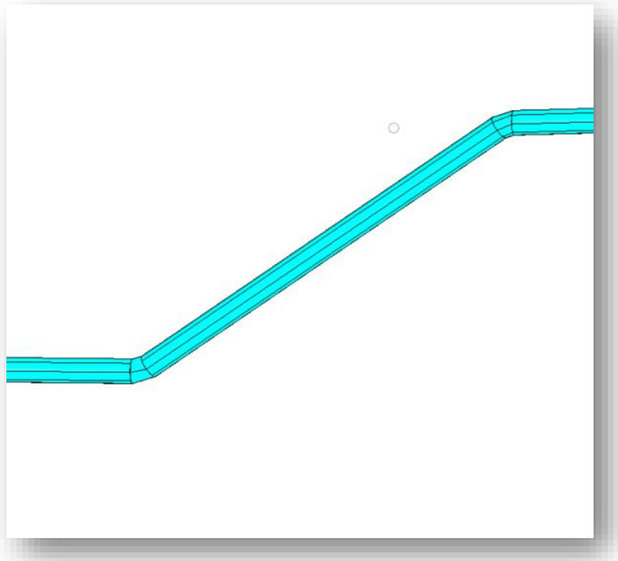
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Single line for general location of culvert or pipe. I-2 criteria: Attributes for pipe/culvert size, shape, invert elevations, and slope. 3D Representation: Use feature definition with 3D solid for pipe/culvert Final Design Office Meeting (FDOM) D-3 criteria: Single line for final location of culvert or pipe. I-3 criteria: Attributes for pipe/culvert size, shape, material, roughness, invert elevations, and slope. Attach ECMS item attributes. 3D Representation: Use feature definition with 3D solid for pipe/culvert Plan/Specifications and Estimate (PS&E) D-3 criteria: Single line for final location of culvert or pipe. I-3 criteria: Attributes for pipe/culvert size, shape, material, roughness, invert elevations, and slope. Attach ECMS item attributes. 3D Representation: Use feature definition with 3D solid for pipe/culvert	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 49 - TEMPORARY ROCK APRON

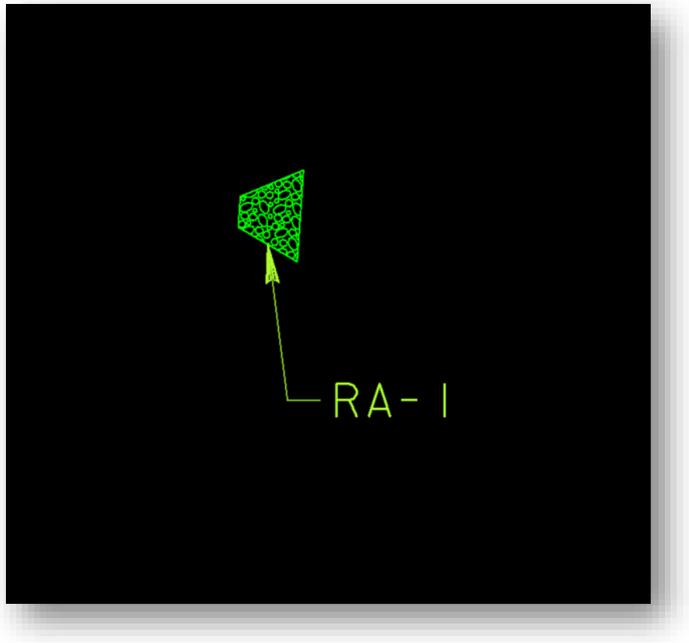
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard rock apron cell. I-2 criteria: Attributes for baseline, station, and offset. 3D Representation: none Final Design Office Meeting (FDOM) D-3 criteria: Standard rock apron cell. I-3 criteria: Attributes for baseline, station, offset, apron length, apron initial width, apron final width, material, and depth. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard rock apron cell. I-3 criteria: Attributes for baseline, station, offset, apron length, apron initial width, apron final width, material, and depth. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 50 - TEMPORARY CHANNELS (DIVERSION, COLLECTION, CONVEYANCE)

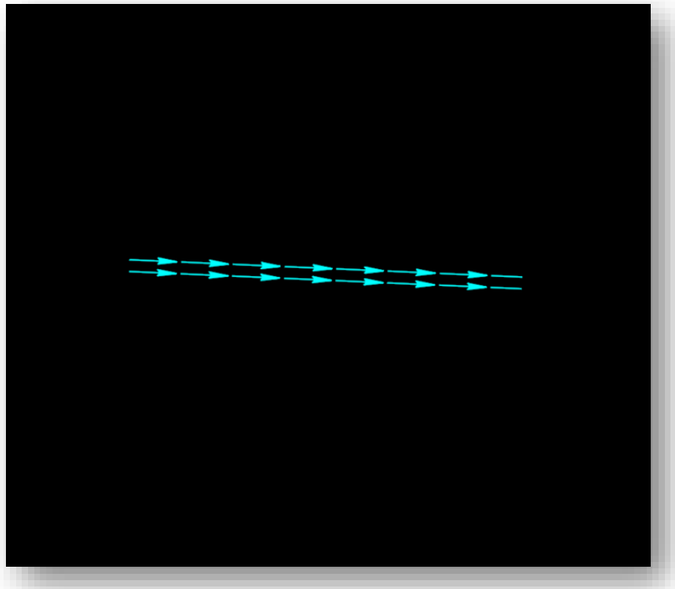
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-2 criteria: Attributes for channel inverts and slope. 3D Representation: Graded bottom and side slopes. Final Design Office Meeting (FDOM) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, lining roughness, check dam height, check dam spacing, planting media depth. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes. Planting media component. Rock lining depth (if applicable). Check dams. Plan/Specifications and Estimate (PS&E) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, lining roughness, check dam height, check dam spacing, planting media depth. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes. Planting media component. Rock lining depth (if applicable). Check dams.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 51 - TEMPORARY STREAM CROSSING

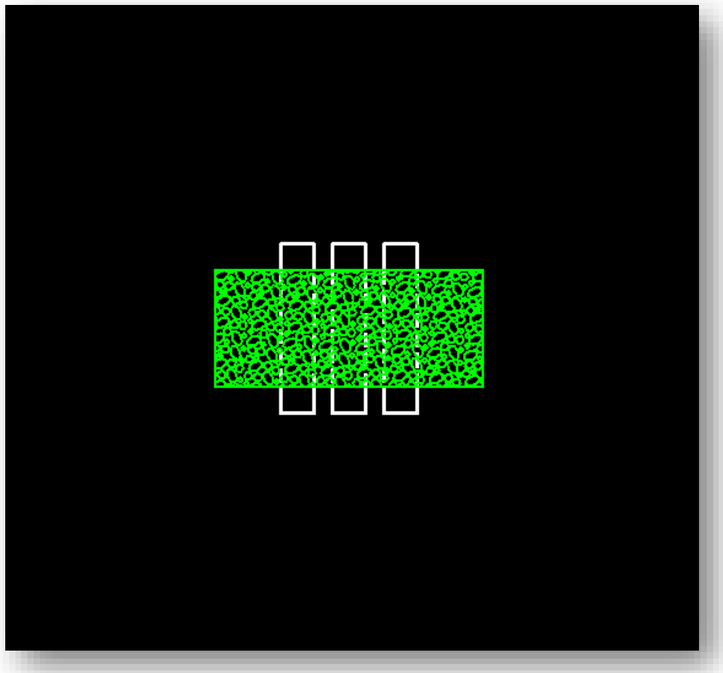
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Footprint of stream crossing. I-2 criteria: Attributes for crossing type and stage. 3D Representation: None. Final Design Office Meeting (FDOM) D-3 criteria: Footprint of stream crossing and detail of components as appropriate. I-3 criteria: Attributes for crossing type, footprint area, pipe sizes (if present), stream impact area, crossing elevations, and stage. Attach ECMS item attributes. 3D Representation: None Plan/Specifications and Estimate (PS&E) D-3 criteria: Footprint of stream crossing and detail of components as appropriate. I-3 criteria: Attributes for crossing type, footprint area, pipe sizes (if present), stream impact area, crossing elevations, and stage. Attach ECMS item attributes. 3D Representation: None	 **Example 1 - 2D Representation**

FIGURE 52 - TEMPORARY COFFERDAM

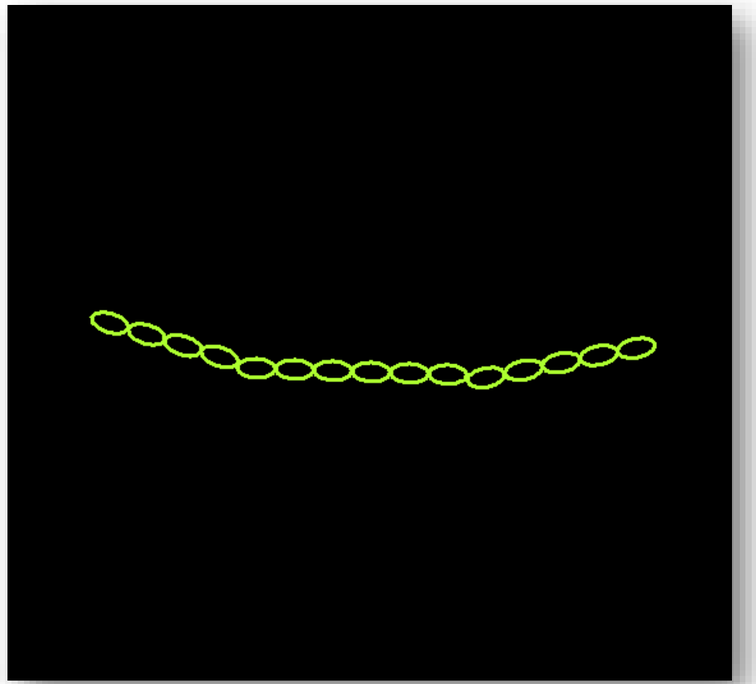
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Polyline with cofferdam linetype. I-2 criteria: Attributes for size, baseline, station, offset and stage. 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Polyline with cofferdam linetype. I-3 criteria: Attributes for size, baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Polyline with cofferdam linetype. I-3 criteria: Attributes for size, baseline, station, offset, and stage. Attach ECMS item attributes. 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 53 - STORMWATER POND/RAIN GARDEN

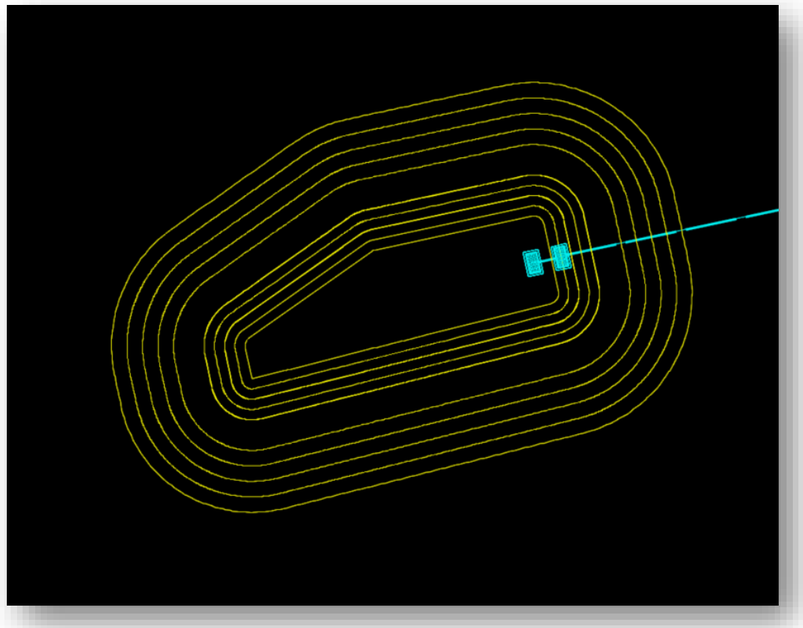
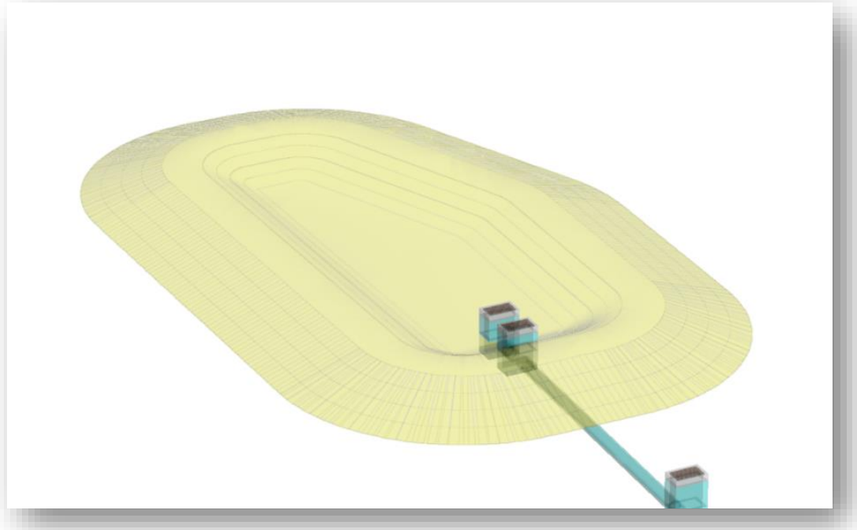
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Outline of top of basin or rain garden berm I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Basin grading displayed with contours in plan. Outlet structure and outlet pipe shown. I-2 criteria: Attributes for BMP ID, type, and storage volume. 3D Representation: Grading for basin/rain garden berm, side slopes, and bottom. Outlet structure & outlet pipes. Stormwater Management Committee Meeting & Final Design Office Meeting (FDOM) D-3 criteria: Basin grading displayed with contours in plan. Outlet structure, outlet pipe, and underdrain layout shown. I-3 criteria: Attributes for BMP ID, type, storage volume, outlet structure orifice sizes, media/aggregate layer void ratios. Attach ECMS item attributes. 3D Representation: Grading for basin/rain garden berm, side slopes, bottom, and emergency spillway. Soil and aggregate layers. Underdrain network with wyes and cleanouts. Outlet structure with orifices detailed, outlet pipes, anti-seep collars. Plan/Specifications and Estimate (PS&E) D-3 criteria: Basin grading displayed with contours in plan. Outlet structure, outlet pipe, and underdrain layout shown. I-3 criteria: Attributes for BMP ID, type, storage volume, outlet structure orifice sizes, media/aggregate layer void ratios. Attach ECMS item attributes. 3D Representation: Grading for basin/rain garden berm, side slopes, bottom, and emergency spillway. Soil and aggregate layers. Underdrain network with wyes and cleanouts. Outlet structure with orifices detailed, outlet pipes, anti-seep collars.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 54 - UNDERGROUND DETENTION SYSTEM/SUBSURFACE STORAGE

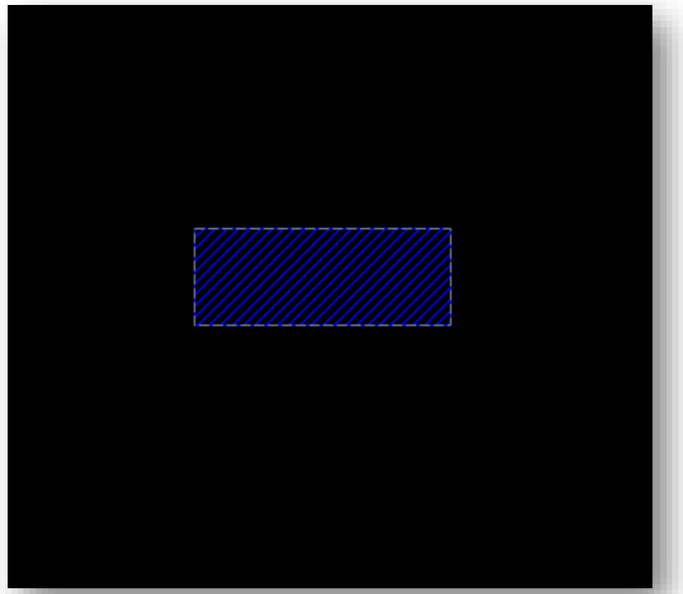
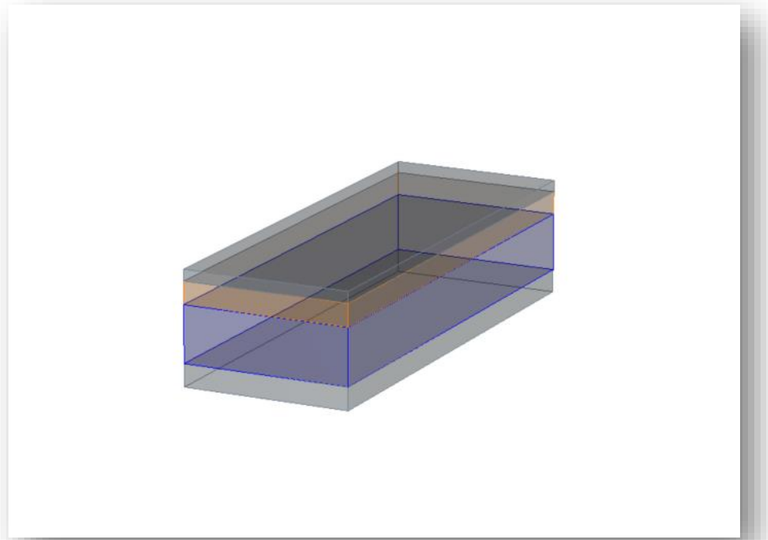
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) & Stormwater Management Committee Meeting D-1 criteria: Outline of underground system footprint I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Underground system footprint and structural features (e.g. modular components) or aggregate layer footprint. Above grade grading displayed with contours on plan. Inlet and outlet structures and pipes shown. I-2 criteria: Attributes for BMP ID, type, and storage volume. 3D Representation: Underground system structural components or aggregate layers modeled as 3D solids. Grading for above grade surface. Inlet and outlet structures and pipes. Final Design Office Meeting (FDOM) D-3 criteria: Underground system structural features (e.g. modular components) or aggregate layer footprint. Above grade grading displayed with contours in plan. Inlet and outlet structures and pipes shown. Basin grading displayed with contours on plan. Underdrain layout shown. Outlet structure, outlet pipe, and underdrain layout shown. I-3 criteria: Attributes for BMP ID, type, storage volume, outlet structure orifice sizes, aggregate layer void ratios. Attach ECMS item attributes. 3D Representation: : Underground system structural components or aggregate layers modeled as 3D solids. Grading for above grade surface. Underdrain network with wyes and cleanouts. Inlet and outlet structures and pipes. Plan/Specifications and Estimate (PS&E) D-3 criteria: Underground system structural features (e.g. modular components) or aggregate layer footprint. Above grade grading displayed with contours in plan. Inlet and outlet structures and pipes shown. Basin grading displayed with contours on plan. Underdrain layout shown. Outlet structure, outlet pipe, and underdrain layout shown. I-3 criteria: Attributes for BMP ID, type, storage volume, outlet structure orifice sizes, aggregate layer void ratios. Attach ECMS item attributes. 3D Representation: : Underground system structural components or aggregate layers modeled as 3D solids. Grading for above grade surface. Underdrain network with wyes and cleanouts. Inlet and outlet structures and pipes.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 55 - VEGETATED CHANNEL (PERMANENT)

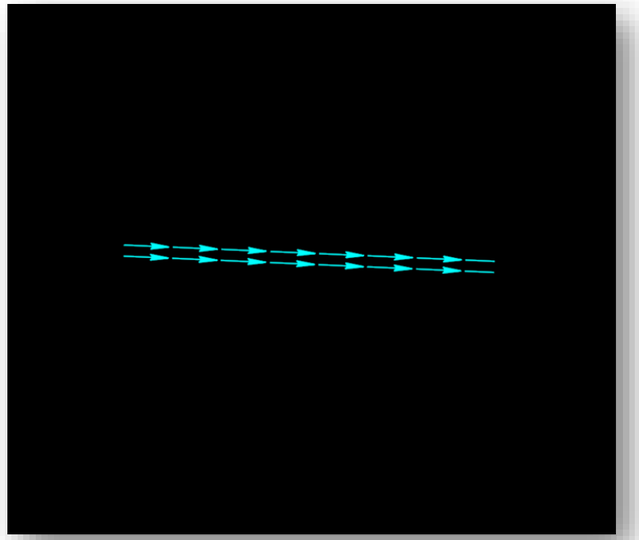
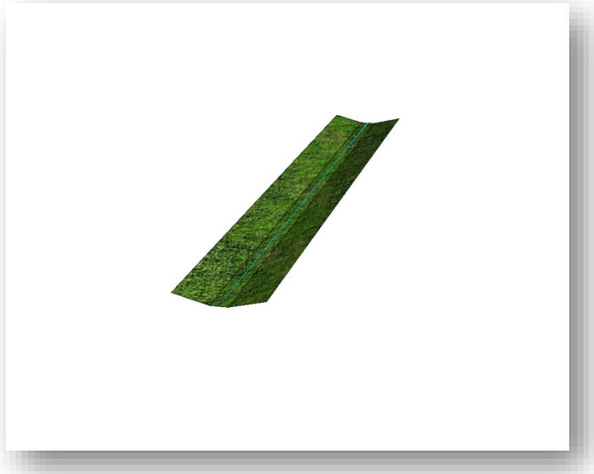
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) & Stormwater Management Committee Meeting D-1 criteria: Single line for channel centerline. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-2 criteria: Attributes for channel inverts and slope. 3D Representation: Graded bottom and side slopes. Final Design Office Meeting (FDOM) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, lining roughness, check dam height, check dam spacing, planting media depth. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes. Planting media component. Rock lining depth (if applicable). Check dams. Plan/Specifications and Estimate (PS&E) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes channel inverts, slope, velocity, flow capacity, lining type, lining roughness, check dam height, check dam spacing, planting media depth. Attach ECMS item attributes. 3D Representation: Graded bottom and side slopes. Planting media component. Rock lining depth (if applicable). Check dams.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 56 - AMENDED SOILS/PLANTING SOILS/TREE PITS

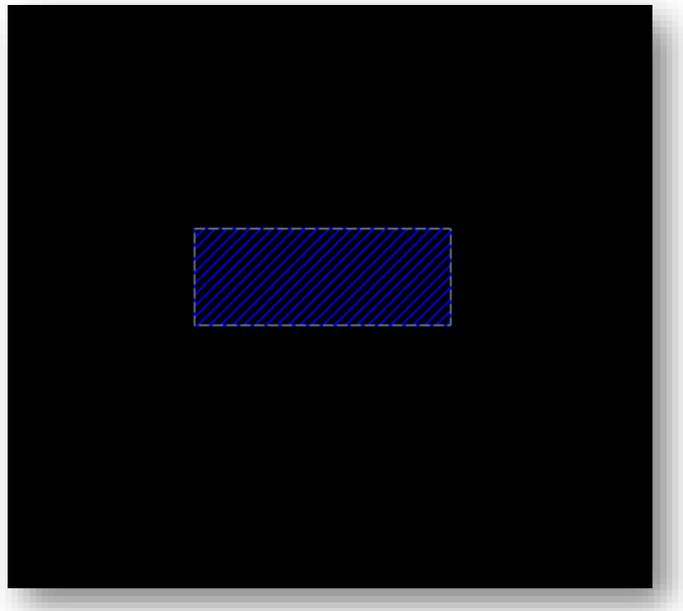
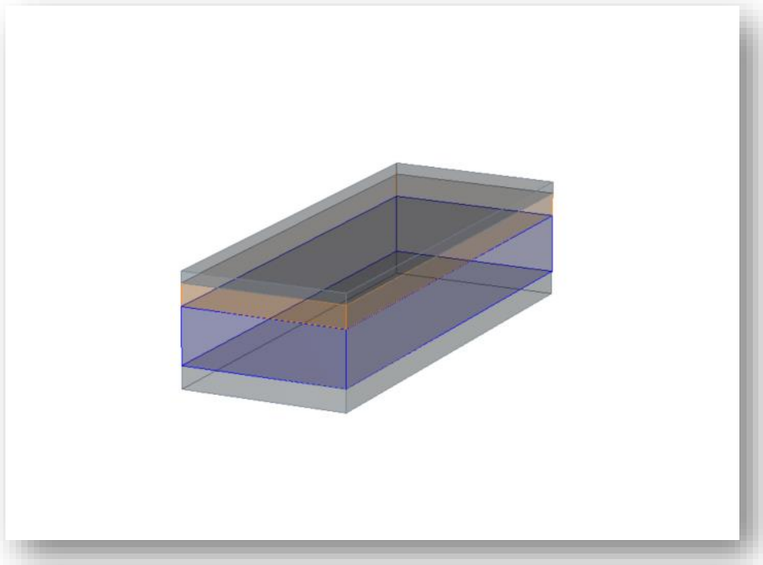
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) & Stormwater Management Committee Meeting D-1 criteria: Outline of proposed BMP area I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Footprint of amended soil/planting soil area (if not part of another BMP. I-2 criteria: Attributes for depth and material. 3D Representation: 3D solid of soil layer. Final Design Office Meeting (FDOM) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes for depth, material, area, and void ratio/infiltration rate (as applicable). Attach ECMS item attributes. 3D Representation: 3D solid of soil layer. Plan/Specifications and Estimate (PS&E) D-3 criteria: Single line for triangular channels and double line for trapezoidal channels. Grading contours for channel bottom and side slopes. I-3 criteria: Attributes for depth, material, area, and void ratio/infiltration rate (as applicable). Attach ECMS item attributes. 3D Representation: 3D solid of soil layer.	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

FIGURE 57 - WATERBODIES AND WETLANDS

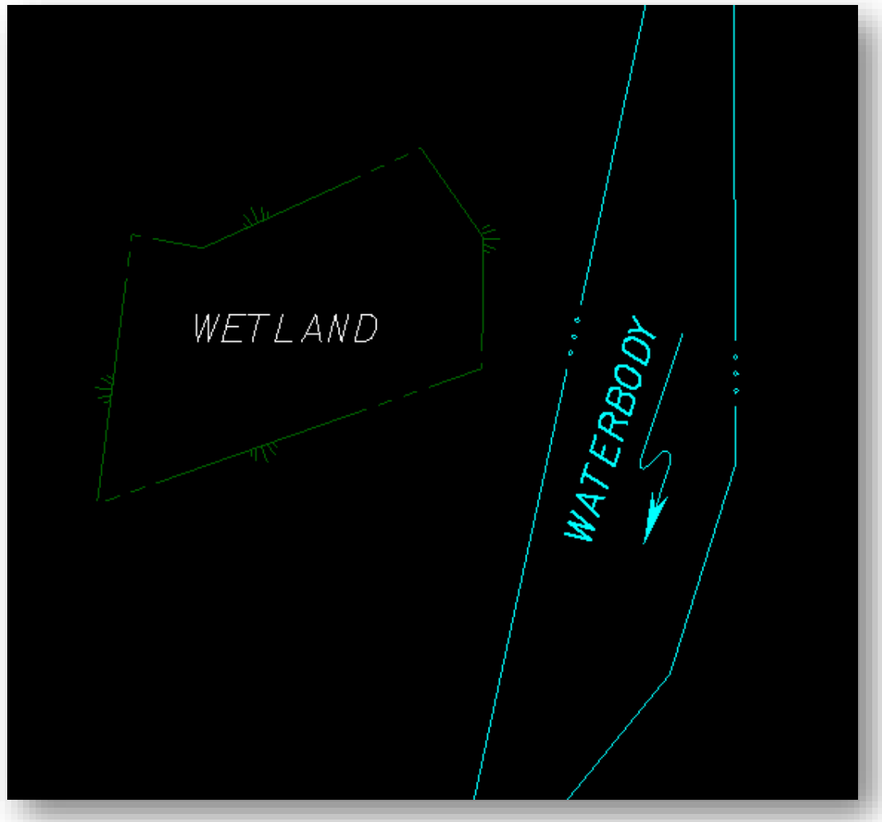
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard linetype for wetlands and waterbodies. Label with waterbody name (or as a tributary if unnamed) and flow arrow. I-1 criteria: none 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard linetype for wetlands and waterbodies. Label with waterbody name (or as a tributary if unnamed) and flow arrow. I-3 criteria: Attributes for Ordinary High-Water elevation (waterbodies) or footprint area (wetlands) 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard linetype for wetlands and waterbodies. Label with waterbody name (or as a tributary if unnamed) and flow arrow. I-3 criteria: Attributes for Ordinary High-Water elevation (waterbodies) or footprint area (wetlands) 3D Representation: none	 **Example 1 - 2D Representation**

FIGURE 58 - REGULATORY BOUNDARIES

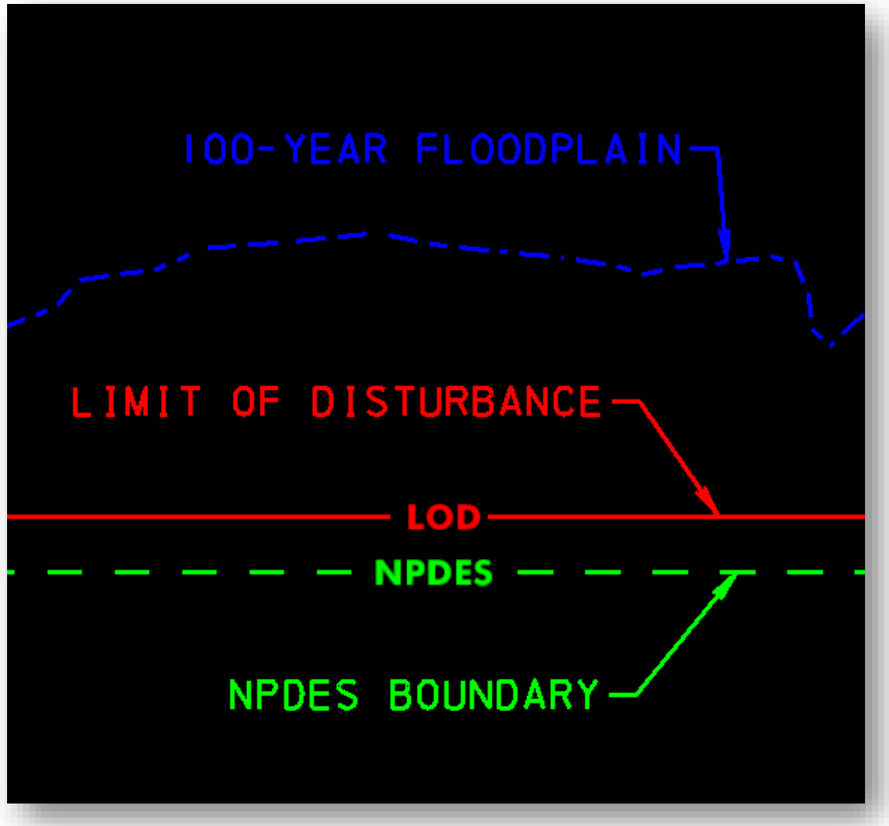
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: E&S design not part of LG&TS submittals. I-1 criteria: none 3D Representation: none Design Field View (DFV) D-2 criteria: Standard linetype for Limit of Disturbance, NPDES Boundary, or 100-year Floodplain I-1 criteria: none 3D Representation: none For large projects, only E&S features that impact ROW are displayed for DFV. Final Design Office Meeting (FDOM) D-3 criteria: Standard linetype for Limit of Disturbance, NPDES Boundary, or 100-year Floodplain I-3 criteria: Attributes for footprint area. 3D Representation: none Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard linetype for Limit of Disturbance, NPDES Boundary, or 100-year Floodplain I-3 criteria: Attributes for footprint area. 3D Representation: none	 **Example 1 - 2D Representation**

Table 8. Traffic Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representations
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Signing													
Post Mounted Sign	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 59 - Post Mounted Sign
Sign Structure	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 60 - Sign Structure
Sign Panel (New, relocated, removal)	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 61 - Sign Panel (New, Relocated, Removal)
Delineator	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 62 - Delineators
Pavement Markings													
Pavement Lane Markings	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 63 - Pavement Lane Markings
Pavement Lane Legends	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 64 - Pavement Marking Legends
Pavement Marking Removal	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Flash Warning Device	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Traffic Signal													
Signal Support/Mast Arm & Foundation	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 65 - Traffic Signal Support/Mast Arm & Foundation
Ramp Meter Signal and Signing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Radar/Video Detection	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Loop Detector	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Junction Box	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Conduit	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Controller Cabinet	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Traffic Control													
Temporary Barrier	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Temporary Glare Screen	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Temporary Guide Rail	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Temporary Impact Attenuator	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Type III Barricades	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	

Arrow Panel	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Channelizing Devices	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Temporary Pavement Markings	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Detour Route	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
ITS													
ITS Enclosure	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Conduit	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Junction Box	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Pavement Sensor	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Dynamic Message Sign & Foundation	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
CCTV Camera & Pole	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Roadway Weather Information System	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Lighting													
Light Pole	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	Figure 66 – Light Pole, Luminairie, Bracket Arm
Luminaire	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Bracket Arm	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Conduit	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Junction Box	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	

FIGURE 59 - POST MOUNTED SIGN

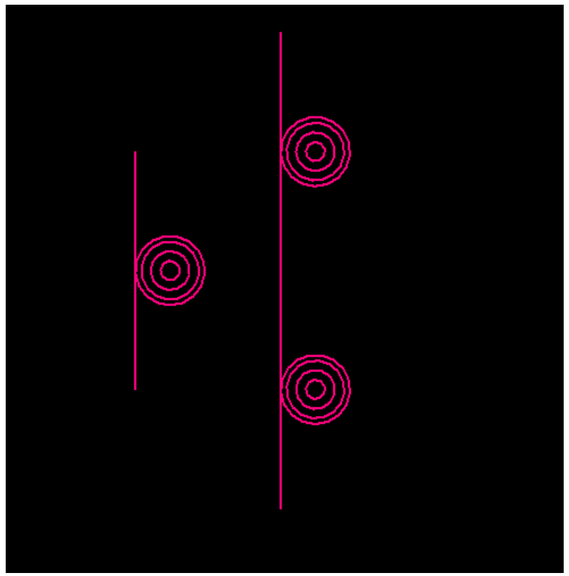
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Signing design not part of LG&TS submittals. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Standard cell for anticipated single or double post mounted sign. I-2 criteria: Attributes for baseline, station, and offset. 3D Representation: None Final Design Office Meeting (FDOM) D-3 criteria: Standard cell for single or double post mounted sign. I-3 criteria: Attributes for baseline, station, and offset. Attach ECMS item attributes. 3D Representation: None Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard cell for single or double post mounted sign. I-3 criteria: Attributes for baseline, station, and offset. Attach ECMS item attributes. 3D Representation: None	 **Example 1 - 2D Representation**

FIGURE 60 - SIGN STRUCTURE

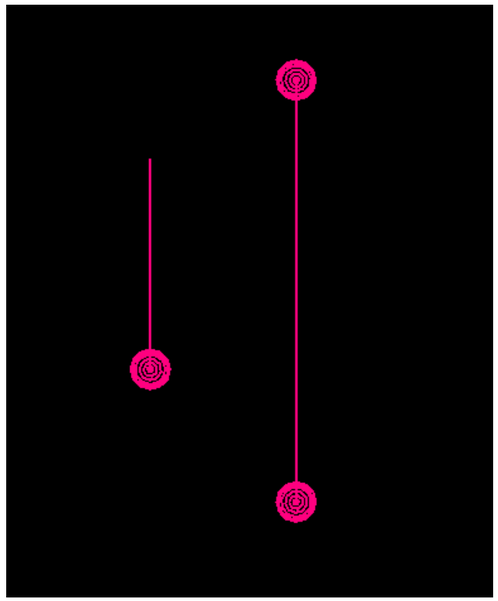
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Signing design not part of LG&TS submittals. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Standard cell for anticipated cantilever or full frame sign structure. I-2 criteria: Attributes for baseline, station, and offset. 3D Representation: None Final Design Office Meeting (FDOM) D-3 criteria: Standard cell for anticipated cantilever or full frame sign structure. I-3 criteria: Attributes for baseline, station, and offset. Attach ECMS item attributes. 3D Representation: None Plan/Specifications and Estimate (PS&E) D-3 criteria: Standard cell for anticipated cantilever or full frame sign structure. I-3 criteria: Attributes for baseline, station, and offset. Attach ECMS item attributes. 3D Representation: None	 **Example 1 - 2D Representation**

FIGURE 61 - SIGN PANEL (NEW, RELOCATED, REMOVAL)

Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Signing design not part of LG&TS submittals. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Cell showing standard or fabricated sign face. I-2 criteria: Attributes for New, Relocated or Removal of sign. 3D Representation: None Final Design Office Meeting (FDOM) D-3 criteria: Cell showing standard or fabricated sign face. I-3 criteria: Attributes for New, Relocated or Removal of sign. Attach ECMS item attributes. 3D Representation: None Plan/Specifications and Estimate (PS&E) D-3 criteria: Cell showing standard or fabricated sign face. I-3 criteria: Attributes for New, Relocated or Removal of sign. Attach ECMS item attributes. 3D Representation: None	 **Example 1 - 2D Representation**

FIGURE 62 - DELINEATORS

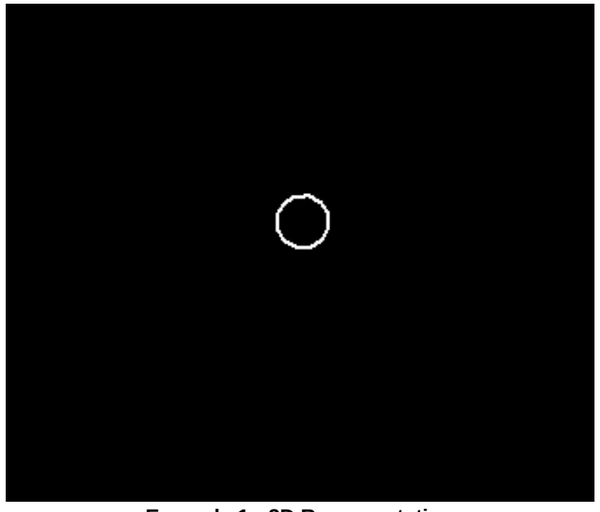
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Signing design not part of LG&TS submittals. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Cell indicating proposed delineator. I-2 criteria: Attributes for mounting location and type of delineator. 3D Representation: None Final Design Office Meeting (FDOM) D-3 criteria: Cell indicating proposed delineator. I-3 criteria: Attributes for mounting location and type of delineator. Attach ECMS item attributes. 3D Representation: None Plan/Specifications and Estimate (PS&E) D-3 criteria: Cell indicating proposed delineator. I-3 criteria: Attributes for mounting location and type of delineator. Attach ECMS item attributes. 3D Representation: None	 **Example 1 - 2D Representation**

FIGURE 63 - PAVEMENT LANE MARKINGS

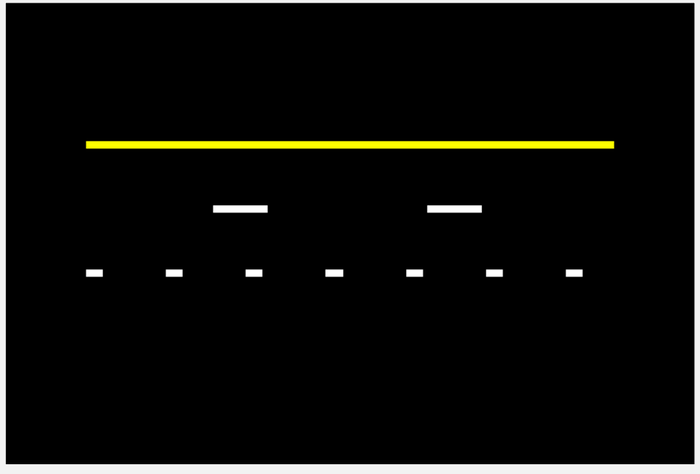
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Linework indicating existing or proposed pavement markings. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Linework indicating existing or proposed pavement markings. I-2 criteria: Attributes for pavement markings width and color. 3D Representation: None. Final Design Office Meeting (FDOM) D-3 criteria: Linework indicating existing or proposed pavement markings. I-3 criteria: Attributes for pavement markings width and color. Attach ECMS item attributes. 3D Representation: None. Plan/Specifications and Estimate (PS&E) D-3 criteria: Linework indicating existing or proposed pavement markings. I-3 criteria: Attributes for pavement markings width and color. Attach ECMS item attributes. 3D Representation: None.	 **Example 1 - 2D Representation**

FIGURE 64 - PAVEMENT MARKING LEGENDS

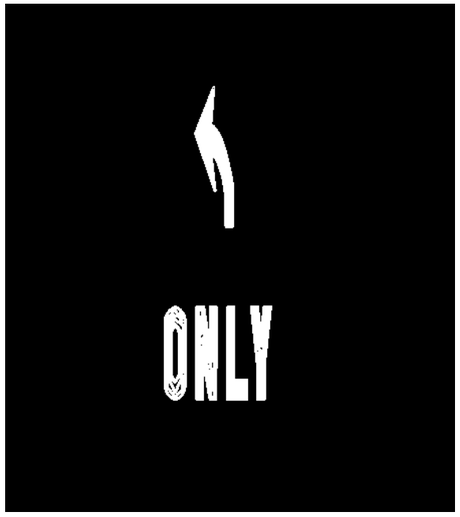
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Cell indicating proposed pavement markings. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Cell indicating proposed pavement markings. I-2 criteria: Attributes for pavement marking color. 3D Representation: None. Final Design Office Meeting (FDOM) D-3 criteria: Cell indicating proposed pavement markings. I-3 criteria: Attributes for pavement marking color. Attach ECMS item attributes. 3D Representation: None. Plan/Specifications and Estimate (PS&E) D-3 criteria: Cell indicating proposed pavement markings. I-3 criteria: Attributes for pavement marking color. Attach ECMS item attributes. 3D Representation: None.	 **Example 1 - 2D Representation**

FIGURE 65 - TRAFFIC SIGNAL SUPPORT/MAST ARM & FOUNDATION

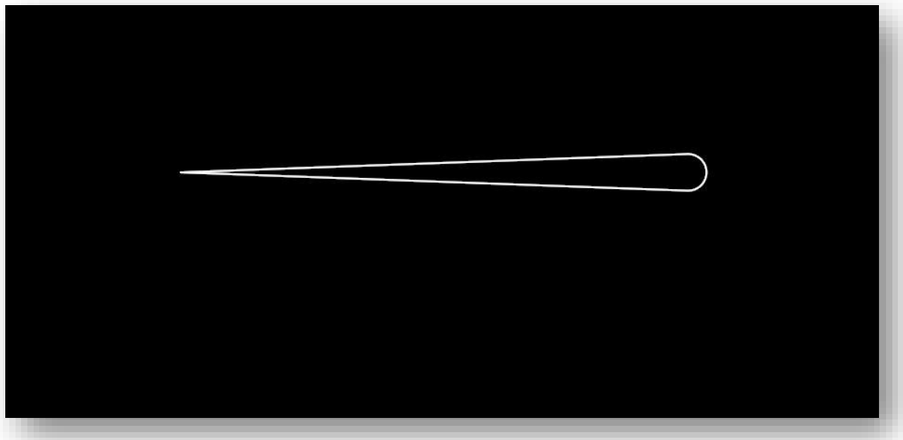
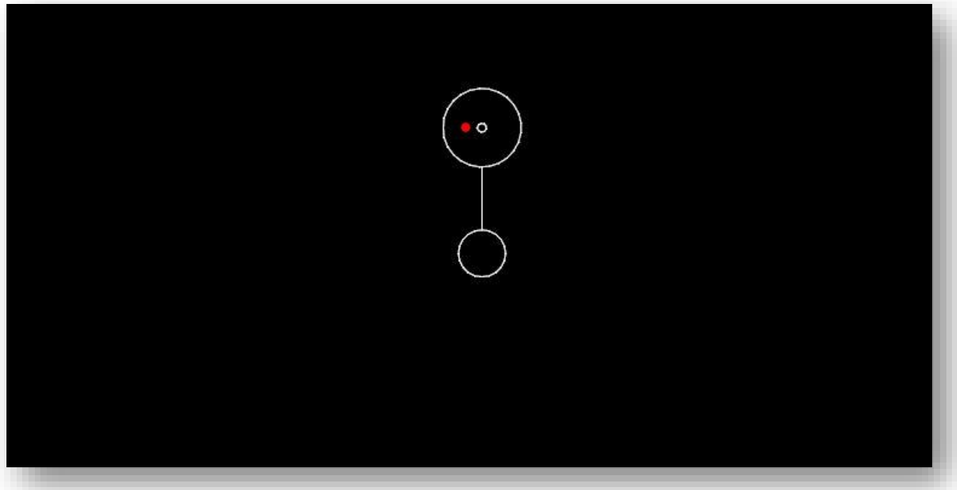
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Traffic signal design not part of LG&TS submittals. I-1 criteria: None 3D Representation: None Design Field View (DFV) D-2 criteria: Cell indicating proposed mast arm length and location of pole/foundation. I-2 criteria: Attributes for specific length of mast arm. 3D Representation: None. Final Design Office Meeting (FDOM) D-3 criteria: Cell indicating proposed mast arm length and location of pole/foundation. I-3 criteria: Attributes for specific length of mast arm. Attach ECMS item attributes. 3D Representation: None. Plan/Specifications and Estimate (PS&E) D-3 criteria: Cell indicating proposed mast arm length and location of pole/foundation. I-3 criteria: Attributes for specific length of mast arm. Attach ECMS item attributes. 3D Representation: None.	 **Example 1 - 2D Representation**

FIGURE 66 – LIGHT POLE, LUMINAIRIE, BRACKET ARM

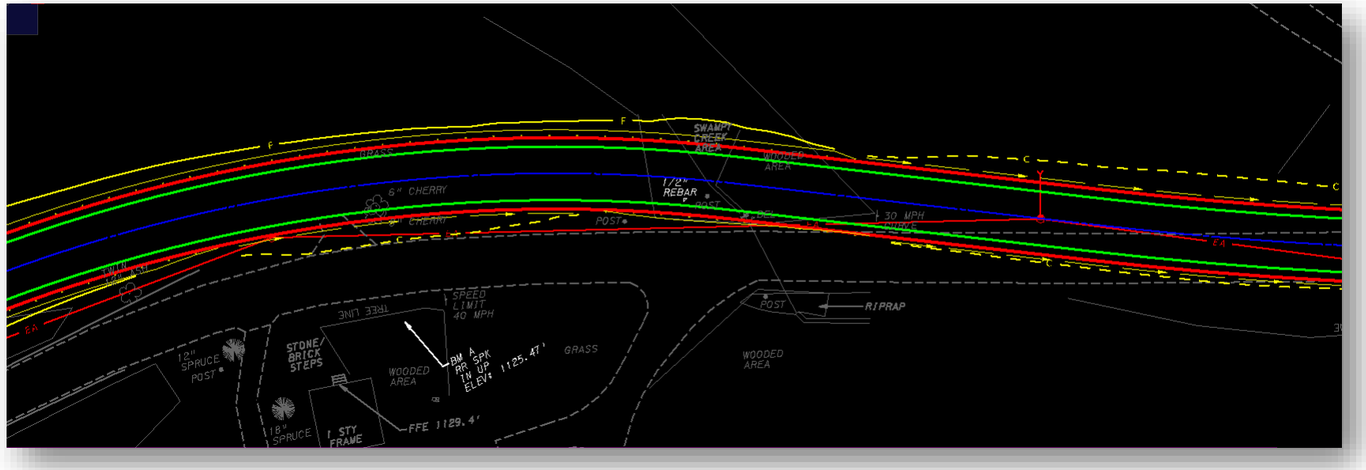
Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: Linework or 2D cell to indicate approximate location I-1 criteria: None 3D Representation: None. Design Field View (DFV) D-2 criteria: Linework or 2D cell to indicate approximate location I-2 criteria: Attributes for specific light pole, luminaire, and bracket arm 3D Representation: None. Final Design Office Meeting (FDOM) D-3 criteria: I-3 criteria: Attributes for specific light pole, luminaire, and bracket arm. Attach ECMS item attributes. 3D Representation: Use feature definition or 3D cell Plan/Specifications and Estimate (PS&E) D-3 criteria: I-3 criteria: Attributes for specific light pole, luminaire, and bracket arm. Attach ECMS item attributes. 3D Representation: Use feature definition or 3D cell	 **Example 1 - 2D Representation**  **Example 2 - 3D Representation**

Utilities

Table 9. Utility Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Utilities													
Cable	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	Figure 67 – Utilities
Communications	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Conduit	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Duct Bank	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Electric	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Fiber Optic	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Gas	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Petroleum	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Sanitary	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Utility Poles and Guys	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Water	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	

FIGURE 67 – UTILITIES

Modeling Criteria	Graphical Representation
Line-Grade and Typical Section (LG&TS) D-1 criteria: General location of existing aerial and underground utilities identified and displayed in 3D. I-1 criteria: Model element information to include type of utility, utility owner (if known), Quality Level from survey. 3D Representation: With proper definition of Quality Level for existing utilities. Design Field View (DFV) D-2 criteria: Approximate location of existing aerial and underground utilities identified and displayed in 3D. Location determined via survey information, review of as-built drawings, and coordination with utility owners. Approximate location of proposed utility relocations identified and displayed in 3D. I-2 criteria: Model element information to include type of utility, utility owner, utility status (public/private), type of relocation work (i.e., prior, restrictive, etc.), Quality Level for existing utilities. 3D Representation: With proper definition of Quality Level for existing utilities. Proposed relocations shall be modeled in 3D following guidance on proper attribution. Final Design Office Meeting (FDOM) D-3 criteria: Specific location of existing aerial and underground utilities identified and displayed in 3D. Location determined via survey information or other 3D location methods. Specific location of proposed utilities identified and displayed in 3D. I-3 criteria: Model element information to include type of utility, utility owner, utility status (public/private), type of relocation work (i.e., prior, restrictive, etc.), Quality Level for existing utilities. 3D Representation: With proper documentation of Quality Level for existing utilities. Proposed relocations shall be modeled in 3D following guidance on proper attribution. Plan/Specifications and Estimate (PS&E) D-3 criteria: Specific location of existing aerial and underground utilities identified and displayed in 3D. Location determined via survey information or other 3D location methods. Specific location of proposed utilities identified and displayed in 3D. I-3 criteria: Model element information to include type of utility, utility owner, utility status (public/private), type of relocation work (i.e., prior, restrictive, etc.), Quality Level for existing utilities. 3D Representation: With proper documentation of Quality Level for existing utilities. Proposed relocations shall be modeled in 3D following guidance on proper attribution.	 **Example 1 – Plan view representation**  **Example 2 - 3D Representation**

Landscaping

Table 10. Landscaping Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Landscaping													
Blanket	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Fence	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Mat	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Netting	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Shrub	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Tree	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Sidewalk	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Sod	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Topsoil	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Walkway	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	

Existing Survey

Table 11. Existing Survey Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Survey Elements													
Ground Surface – Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Topography – Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Right-of-Way limits - Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Easement - Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Public Land Lines	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
City/Town Limit/Boundaries	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Reference Markers - Cells	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Benchmark - Cells	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Equalities - Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Utilities – Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Services – Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Roadway Signs – Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Utility Power Poles - Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Wire Above Ground - Existing	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	

Right of Way

Table 12. Right-of-Way Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Right of Way Elements													
Fences	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Gates	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Line – Required (proposed)	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Line – Legal (existing)	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Property Line – (proposed)	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Easement Line – (permanent)	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	
Easement Line – (temporary)	D-1	I-1	2D	D-2	I-2	2D	D-3	I-3	2D	D-3	I-3	2D	

Rail

Table 13. Rail Model Elements

Model Element	LG&TS			DFV			FDOM / Constructability Review			PS&E			Figure Representation
	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	Min. Detail	Min. Information	2D/3D	
Rail Elements													
Rail	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Crosstie	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Sub-ballast	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Ballast	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Power System	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Catenary System	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	
Platform	D-1	I-1	3D	D-2	I-2	3D	D-3	I-3	3D	D-3	I-3	3D	

Appendix B: PennDOT Example Process Maps

OVERALL PROCESS MAP

BIM USES

INFORMATION EXCHANGES

KEY

Design

Preliminary Design Authoring

Model Author | Preliminary Models

Owner

Project Stage

Use Case

Output

Planning

Existing Conditions Modeling

Survey | Existing Conditions Model

Design

Preliminary Design Authoring

Model Author | Preliminary Models

Design

Develop Visualization

Model Author | Visualization Model

Design

3D Coordination and Clash Detection

PM | Coordination Model

Design

Final Design Authoring

Model Author | Final Models

Design

Conduct Design Review

PM | Design Review

Design

Develop Design Quantities

PM | Design Quantities

Design

Process Contract Documents

PM | Contract Documents

Construction

Construction Planning

Contractor | 4D/5D Model

Construction

Set Construction Layout

Contractor | Construction Layout

Construction

Construction Inspection, Verification and Acceptance

Contractor | Inspection

Construction

Shop Model Authoring

Fabricator | Fabrication Model

Construction

Digital As-Built

Contractor | Record Model

Existing Conditions Model

Roadway Model

Structural Model

Drainage Model

Other

Preliminary Model

Coordination Model

Visualization

Roadway Model

Structural Model

Drainage Model

Other

Final Design Models

Design Quantities

Design Review Information

Contract Documents

Roadway Model

Structural Model

Drainage Model

Other

Construction Model

4D/5D Model

Shop Model

Record Model

Existing Conditions Modeling

REFERENCE INFO.

- As-Built Model Data
- GIS Data
- FEMA Map
- Additional Open Source Data
- Existing ROW Plans
- One Call Utility Data
- Deed Mosaic
- Notice of Entry

PROCESS

- Conduct Scoping Meetings — *Chief of Survey*
- Define Level of Accuracy — *Chief of Survey*
- Define Survey Methods — *Chief of Survey*
- Prepare information for Field Crew — *Chief of Survey*
- Perform Field Survey Data Collection — *Field Crew*
- Process Field Survey Data — *Field Crew*
- Prepare Survey Model — *Crew Chief*
- Perform Quality Review — *Crew Chief*

INFO. EXCHANGE

- Survey Data Collection and Information
- EGCL requirements
- Survey Stakeout Report
- Raw Survey Data
- Existing ROW Report
- Topographic Survey
- 3D Existing Conditions Model
- Existing ROW Files
- Existing ROW Model

Design Authoring

REFERENCE INFO.

Scoping Information

Existing Project Information

Existing Mapping

Existing Conditions Model

Existing Plans

Crash Data

PROCESS

Scoping

Prepare Digital Delivery Execution Plan (DDEP)

Prepare Model Element Breakdown Structure (MEBS)

Prepare Scoping documents

Preliminary Design

Roadway Initial Design Model Development

Roadway Safety Evaluation

Hydraulic Geometric Model Development

Hydraulic Analysis

Structure TS&L Design Model Development

Foundation Design

Drainage Initial Design Model Development

Create other discipline initial models

Design Field View

Final Design

Detailed Roadway Design Model Development

Finalize H&H

Detailed Structural Design Model Development

Detailed Drainage Design Model Development

Other Discipline Model Development as Required

No

Compliant

Yes

QA/QC Review Process

INFO. EXCHANGE

DDEP

MEBS

Roadway Model

Structural Model

Drainage Model

Other

Preliminary Models

Roadway Model

Structural Model

Drainage Model

Other

Final Design Models

Visualization

REFERENCE INFO.

Topographic Survey

3D Existing Model

Existing ROW Files

Roadway Model

Structural Model

Drainage Model

Other

Design Models

Schedule

Cost

PROCESS

No

3D Simulation Development

Designer

4D Simulation Development

Designer

5D Simulation Development

Designer

Rendering Development

Designer

Quality Review

Reviewer

Project Complete?

Yes

INFO. EXCHANGE

3D Simulation Model

4D Simulation Model

5D Simulation Model

Rendering

Design Review

REFERENCE INFO

Digital Delivery Execution Plan

MEBS

Digital Delivery Documentation

Roadway Model

Structural Model

Drainage Model

Other

Design Models

Quality Management Checklist

PROCESS

Prepare milestone deliverables

Model Authors

Compile Review Model(s)

Model Manager

Perform deliverable review

Reviewers

Perform Design Compliance Reviews

Reviewers

Perform Model Integrity Reviews

Reviewers

Quality Review

Compile Design Review Feedback

Reviewers

Design Acceptable?

No

Return to Design Authoring

Model Manager

Yes

INFO. EXCHANGE

Compiled Review Model(s)

Design Review Comments

Compliance Memo

3D Coordination (Clash Detection)

REFERENCE INFO.

Digital Delivery Execution Plan

PROCESS

Compile Review Model

Model Manager

Perform clash detection

Model Manager

Perform 3D coordination

Model Manager

Manageable Collisions

Yes

No

Return to Design Authoring

Model Manager

INFO. EXCHANGE

Roadway Model

Structural Model

Drainage Model

Other

Design Models

Compiled Review Model

Clash Report

Interference Management Memo

Design Quantities

REFERENCE INFO.

MEBS

DDEP

PROCESS

Pull Quantity reports

Model Manager

Verify Quantity reports

Reviewer

INFO. EXCHANGE

Roadway Model

Structural Model

Drainage Model

Other

Design Models

Quantity Reports

Contract Documents

REFERENCE INFO.

MEBS

DDEP

PROCESS

Finalize Contract Documents

Finalize Contract Documents; DDEP & MEBS

Prepare Terrain Model Exports

Prepare Design Model Exports

Publish reports, data files,

Model Manager

Compile Deliverable Model

Model Manager

Set up views within model

Model Manager

QA/QC Published files

Reviewer

Signing and Sealing deliverables

Project Manager

Submission

Project Manager

Publish Project File Index

All disciplines

INFO. EXCHANGE

Roadway Model

Structural Model

Drainage Model

Other

Final Design Models

Data files (.csv, .xlsx)

Reports

Compiled Deliverable Model(s)

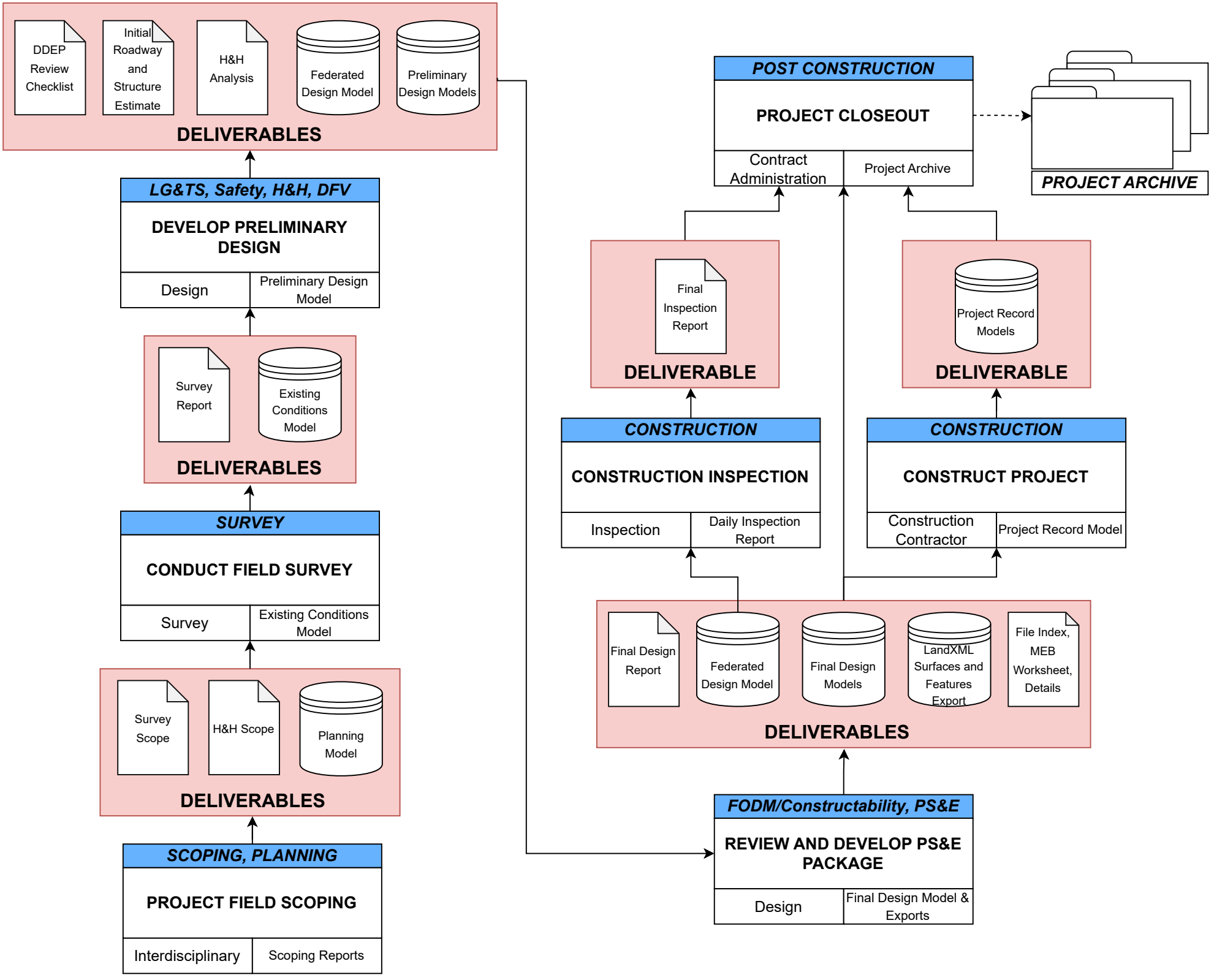
Project File Index

Contract Models

Contract Documents

Contract Deliverables

Appendix C: Preparing and Publishing Digital Deliverables


DDEP Review Checklist
Initial Roadway and Structure Estimate
H&H Analysis
Federated Design Model
Preliminary Design Models
DELIVERABLES
LG&TS, Safety, H&H, DFV
DEVELOP PRELIMINARY DESIGN
Design
Preliminary Design Model
Survey Report
Existing Conditions Model
DELIVERABLES
SURVEY
CONDUCT FIELD SURVEY
Survey
Existing Conditions Model
Survey Scope
H&H Scope
Planning Model
DELIVERABLES
SCOPING, PLANNING
PROJECT FIELD SCOPING
Interdisciplinary
Scoping Reports
POST CONSTRUCTION
PROJECT CLOSEOUT
Contract Administration
Project Archive
PROJECT ARCHIVE
Final Inspection Report
DELIVERABLE
Project Record Models
DELIVERABLE
CONSTRUCTION
CONSTRUCTION INSPECTION
Inspection
Daily Inspection Report
CONSTRUCTION
CONSTRUCT PROJECT
Construction Contractor
Project Record Model
Final Design Report
Federated Design Model
Final Design Models
LandXML Surfaces and Features Export
File Index, MEB Worksheet, Details
DELIVERABLES
FODM/Constructability, PS&E
REVIEW AND DEVELOP PS&E PACKAGE
Design
Final Design Model & Exports