Requirements for Model-Centric Design

Engineering Division

February 2024

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Preface

The ***Requirements for Model-Centric Design*** (*RfMCD*) document is intended to be a guide and reference point for TDOT staff and designers while transitioning to Bentley's OpenRoads Designer (ORD) CONNECT Edition software. There are certain sections of this document which may be beneficial to additional targeted audiences including TDOT's IT Division as well as consultants. This guide outlines general information and terminology associated with the software for legacy/existing project conversions, new deployments, standard file extensions and naming conventions, survey and design deliverables, plans production, and recommendations for model-centric design. In addition, there are multiple appendices which elaborate on topics covered throughout this document.

Although the ***RfMCD*** document does not replace the need for training, it is meant to document standard digital design procedures developed by TDOT and should be referenced throughout each project. This document will continue to be updated as enhancements to the software and its capabilities occur. Revisions will be outlined in the **Revision History** section of the document.

Chapter 1. General

1.1 General Background

Beginning in **July 2021**, TDOT migrated from MicroStation V8i (SELECT series2) and GEOPAK to Bentley's **OpenRoads Designer (ORD) CONNECT Edition** software for new surveys, transportation design and project plans development. This has seamlessly blended engineering workflows for plan, profile, and cross sections with 3D parametric modeling to ultimately enable model-centric design deliverables. ORD is a comprehensive and fully functioned detailed design application for surveying, drainage, subsurface utilities, and roadway design that supersedes all capabilities previously delivered through InRoads, GEOPAK, MX and PowerCivil.[1]

Previously, the workflow for project design development included transforming base map data (e.g., surface models, aerial imagery, planimetrics, and other existing conditions data) into a CAD environment from which the design is based. The designer would then use GEOPAK to incorporate engineering decisions into the CAD environment that builds separate plan, profile, and cross section sheets conveying the overall design intent. Conversely, ORD allows graphics, geometry, and surface data to be stored in a single format (e.g., DGN), therefore, streamlining the workflow and interface. Ultimately, this software enables designers to build a comprehensive **3D** model which showcases a collaborative design effort and more clearly conveys the design intent.

There are numerous benefits when transitioning from the previous platform to ORD, including:

- Use of digital data throughout the life of a project.
- Improved execution of the designer's engineering design intent and continuity across TDOT regions.
- Ability to deliver a higher quality product to the contractor with a more accurate project footprint related to earthwork and construction limits.
  - This includes **Automated Machine Guidance** (AMG) which uses data from the project's 3D model to guide construction equipment during earthwork and paving operations.
- Creation of a better visualization tool for engineering analysis and coordination with other design disciplines.

With ORD, project deliverables will continue to be in the form of a **sealed PDF plan set**, which represents the contractual legal document. The **3D model** will serve as **supplemental** data at this time. In the future, TDOT will migrate to full digital delivery, referenced more commonly as **Electronic Engineering Data** (EED), which can be consumed further downstream for Asset Management and Maintenance.

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[1] "OpenRoads - Civil Design Software for Road Networks," *Bentley*, https://www.bentley.com/software/road-and-site-design/

1.2 Terminology

While some terms are previously known, ORD does introduce new terms and processes, some of which are listed below. Knowing this terminology will allow designers to have a better understanding of the software and application of it.

> *These terms may not be utilized within this document but are referenced in the TDOT ORD training manuals.*

Take Note!

- **Configuration:** TDOT-specific files that control where the software looks for different workspace components.
- **Corridor:** Objects that make up the proposed roadway, such as template drops, point controls, end condition exceptions, parametric constraints, etc.
- **Geometry:** Horizontal and vertical alignments.
- **Intelligent Data:** 2D/3D data that the software automatically accesses across model spaces to link or affect another model space within that file or other files. Fundamentally this results in a cause-and-effect relationship across model spaces. This includes geometries, corridor elements, annotation etc.
- **Model Annotation:** This is how ORD handles "intelligent" annotation, such as alignment stationing and bearings/distances, survey elements such as pipes, buildings, and trees, as well as profile/cross section elevations, dimensions, and volumes.
- **Seed File:** A file template, ensuring that newly created files have default parameters, such as working units, color table, views, etc. that are aligned with TDOT Standards).
- **Sheet Index:** An organized and named collection of sheet models from one or more design files which also contains controls to manage automation.
- **Template Library:** Contains the standard templates based on TDOT standard drawings and is the basis for corridor modeling.
- **Terrain:** A surface model that represents the existing ground, proposed design, or other surfaces. These are referred to as digital terrain models (DTMs).
- **TIN (Triangulated Irregular Network) File:** A visual of a topographical surface utilizing points, lines, and polygons that contain elevation information to create a functional surface.
- **Unintelligent Data:** 2D data that the software cannot automatically access across model spaces and has no inherent cause and effect relationship across model spaces. This data is often referred to as MicroStation as it utilizes the base drafting technology that underpins the ORD software.

- **Workflow:** Allows the applicable tools to display in a project specific order across the Ribbon.
- **Workset:** A project folder where the designer will store all project files.
- **Workspace:** A collection of TDOT standard settings that control how the software works.

1.3 Standard File Naming

The TDOT ORD File Naming Convention Standards document was created to provide guidance and consistency for all project files developed in ORD. Some projects will not utilize all the files listed in this document. Conversely, some projects may require additional files compared to what is listed, and designers should follow the naming convention established in this document to develop an appropriate file name. This document contains the following sections:

- Standard file extensions
- Standard **survey** workflow and file standardization, including:
    - Survey project file naming convention
    - Survey project deliverables
- Standard **design** workflow and file standardization, including:
    - Design project file naming convention
    - Design project deliverables

Within the appendix of the TDOT ORD File Naming Convention Standards is an inventory of project files, broken down into the following project development phases:

- Planning (e.g., PDN Stage 0 Strategic Transportation Investments Division)
- Survey, Design, and Operations

1.4 2D vs. 3D

As noted in the TDOT ORD File Naming Convention Standards (discussed in the previous section), there is guidance on whether to utilize a 2D or 3D seed file when creating project files. In ORD, it is very important to be cognizant of what is placed in a 2D model vs a 3D model; therefore, it is important for users to understand the difference and interaction of these files.

- **TDOTSeed2D:** Contains a 2D model and is the seed file that will be most utilized by designers. Once a 3D element is created in this model, a 3D model will be created. This 3D model is meant for visualization purposes only. Changes in the 2D model will affect the 3D model. Designers should not create design elements in the 3D model. This file will be used for any file that requires 2D and 3D models, with the 3D model being created by having a 3D element active in the file (activating a terrain).

- **TDOTSeed2DStructures**: Contains a 2D model and is the seed file that will be utilized mostly by structural designers. This seed file has design file settings which align with structural design standards. This seed file should only be used to design structures that are then referenced into other design files.

- **TDOTSeed3D:** Contains only a 3D model by default. When a 3D seed is required, work should be performed in the 3D model. For these files, the 3D model is not just a visualization and contains survey data or a digital terrain model. <u>This seed file also contains survey information text, a survey disclaimer, control point table, utility owners, and a north arrow at the origin point. If creating any file other than the **SUR-Model.dgn** file, these elements can be deleted.</u>

- **TDOTSeed3DAerial:** Contains only a 3D model by default. This seed file is only used when working with aerial survey files.

Imported survey data should be placed in a 3D file. This will facilitate the creation and placement of terrain models, drainage data, and other survey features where the elevation is critical. However, certain aspects of a survey (e.g., alignments) require elements to be placed in a 2D seed model and then have a profile assigned. In general, once a profile is assigned to a 2D element, a 3D representation is then drawn in the 3D model that utilizes the assigned profile to give the element elevation data. This separates the 2D geometric elements from their 3D representation, which is imperative.

The Survey (ORD) Manual instructs the designer on when to use a 2D or 3D seed file for survey file creation. Refer to Appendix D for additional information. To summarize, the five (5) survey file deliverables will utilize both 2D and 3D seed files as follows:

1. **Aerial Survey Data** file (**Aerial Model.dgn** from the **3D seed**) contains the existing graphics imported from the aerial survey. <u>This is only required as a survey deliverable on projects with an aerial survey included in the scope</u>.

2. **Field Survey Data** file (**Model.dgn** from the **3D seed**) contains the existing graphics imported from the original Field Book(s) (e.g., utilities (plan), pavement edges, buildings, vegetation, etc.).

3. **Terrain Model** file (**Terrain.dgn** from the **3D seed**) contains the existing DTM features (e.g., contours, triangles, etc.). If a project requires a Field Survey Data file and an Aerial Survey Data file, the Terrain Model file should combine both the field survey TIN file and the aerial survey TIN file.

4. **Preliminary Geometry** file (**Alignment.dgn** from the **2D seed**) contains the survey preliminary centerline horizontal alignment with profile, existing right-of-way lines, property lines, parcel lines, property owners, tract numbers, and projected existing drainage and utilities (profile only). When there is significant benefit to the project, as determined by TDOT and both the survey and design teams during early project coordination, mainline and side road alignments may be separated into multiple Alignment.dgn files. This approach may warrant significant benefit on large projects and/or projects where multiple resources need to work on alignment information. In this case, the complete property map should be included in the mainline Alignment.dgn (not separated into multiple Alignment.dgn files).

5. **Utility Model** file (**Utility.dgn** from the **2D seed**) contains the existing drainage and utility models (plan only), delineated drainage areas, and drainage/hydraulic data blocks.

The ORD Survey Files – Office QAQC Checklist has been developed and should be used by the survey team once all data has been processed and deliverables are developing in preparation to submit all survey files to design. Additional Information sections in the checklist(s) should be used to document specific project information not detailed in the checklist(s). For example, documentation on the coordination between TDOT and both the survey and design teams regarding the multiple Alignment.dgn survey deliverable files, noted in item #4 above, should be detailed in the checklist(s) for project documentation purposes.

Furthermore, most Design files utilize a **2D** seed file, as noted in the inventory of project files listed in the TDOT ORD File Naming Convention Standards (except for proposed terrain files). Horizontal geometry must **always** be stored in 2D models, which provides several advantages:

- The feature definitions allow for different 2D and 3D representations. The user can consider the 2D as the planimetric design plus annotation and the 3D as the visualization model.

- With separated 2D information, rotated 3D views will only show elements with the elevation assigned and no information will show at elevation zero.

- Selection of elements is simplified when separated into 2D and 3D storage models. References can be turned off or left on (with snaps turned off).

Chapter 2. Workspace Setup and Management

2.1 Workspace Structure

A **workspace** is a collection of standard settings that control how the ORD software works. A single TDOT workspace (**TDOT_Standards**) has been created with a layered structure and includes resources, standards, and tools necessary for designing projects in accordance with TDOT standards. The default Bentley ORD installation process puts the workspace configuration files on the **C:** drive. The following sections provide more details on the layered structure.

- **Organization-Civil:** This level represents the Bentley-delivered base standards and allows the flexibility to set up a layered TDOT-specific workspace environment within, which includes the TDOT standards, so they are applied to all ORD projects.

- **Workspace:** This level allows an organization to set up specific standards for different functional units or disciplines. Within the **TDOT_Standards** ORD workspace, there are components setup for the following transportation disciplines: Survey, Roadway, Drainage (SUDA), and Structures.

- There are two (2) options for installing and running the workspace: local user's hard drive (e.g., **C:** drive) or a specified shared network location. For TDOT designers and staff, TDOT IT and CADD Support will provide guidance on workspace installation. However, for external users, Appendix C outlines the installation process.

- **Workset:** This level is directly tied to sheet indexing and allows TDOT to specify standards for a project that supplements the primary Workspace and/or Organizational standards. The workset folders are equivalent to project folders. Four (4) standard workset templates have been developed and are included in the TDOT workspace:
  - **RDWY_TEMPLATE:** This workset template should be used by the **Planning (STID)**, **Survey**, **Design**, and **Operations** staff as a basis for all new roadway design project worksets.
    - **Note:** For non-training purposes, users would traditionally use the **RDWY_TEMPLATE**.
  - **STR_TEMPLATE:** This workset template should be used by the **Structures** Division as a basis for all new structures project worksets.
  - **SUDA_Training:** This is a **training** workset template and is intended for users focusing on hydraulic analysis and drainage calculations for proposed storm drain networks (e.g., drainage and utility modeling workflow in ORD).
  - **SURVEY_Training:** This is a **training** workset template and is intended for Geodetics staff.

When a project workset is created, a workset folder and two corresponding files (.cfg and .dgnws) are created (Figure 1) in a location specified by the **WorkSpaceSetup.cfg** file. See Section 2.1.1 for guidance on making changes to this file. If no customizations are made, the new workset will be created in the Bentley default location:

C:\ProgramData\Bentley\Open Roads Designer XX\Configuration\WorkSpaces\ TDOT_Standards\WorkSets

Within the workset folder is a series of subfolders that are automatically created and are initially empty. As project data develops, the folders are populated with DGN files, spreadsheets, databases, and other files. It is recommended to create a new workset for each new project, rather than copying or using a previous project's workset.

Similar to the workspace setup, workset folders may be placed either locally on the user's **C:** drive or in a standard shared network location. TDOT will continue to install the workset to each user's local hard drive. There is also a unified shared network configuration option which aligns with current TDOT practices that some may option to utilize. In the future, the workset location will have to be modified once TDOT transitions to ProjectWise within Bentley's Infrastructure Cloud.

- Headquarters staff – Local hard drive
- Regional staff – Unified shared network configuration (*the # stands for the Region number*)
    - The proposed ORD shared network drive path is the following: **TDOT0#NAS002.tdot.state.tn.us\0#Shared\ORD\Projects**

FIGURE 1. WORKSET FILE AND FOLDER STRUCTURE
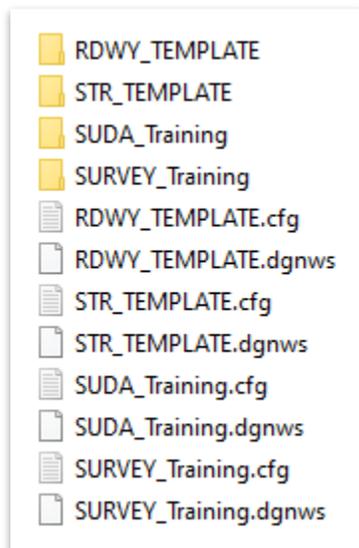
2.1.1 Creating a Workspace and a Workset on a Shared Network Drive

Some designers will continue to have the workspace and worksets placed on the local **C:** drive. However, some design teams will benefit by having the workspace and/or worksets on a shared network drive. The following describes the steps needed to implement this approach.

For the following example, the configuration will still be placed on the **C:** drive of an individual computer. The workspace and worksets will be placed on a different shared network drive. For each computer's configuration, the following configuration workspace setup file will need to be changed.

1. Under the main **Configuration** folder, open the **WorkSpaceSetup.cfg** file.
2. To change the workspace to a shared network drive and store the workset in the **same** location, follow the steps below:
   - Under the **WorkSpace Standard Location**, change the code in the box below to point to the folder location that will contain the **TDOT_Standards** folder and **TDOT_Standards.cfg** file. Uncomment the line (e.g., remove the **#** at the beginning of the line) to redirect the code to this shared network location (Figure 2).

FIGURE 2. WORKSPACE STANDARD LOCATION

```
#==============================================================================
# WorkSpace Standard Location
#==============================================================================
# WorkSpace standards are extensions or overlays to an Organization standard.
# A common use for WorkSpace standards is for company or client standards.
# Organization + WorkSpace + WorkSet = OpenRoads Designer Environment
#
# By default WorkSpace standards are located at
# \ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\
#
# The default location can be changed using the _USTN_WORKSPACESROOT variable.
# To redirect just the WorkSpace folder to a network location, uncomment the
# following line and replace the network path with the appropriate network path.
#
# <<<< Make Changes Here >>>>
#MY_WORKSPACES_LOCATION = c:/Configuration/WorkSpaces/

%if defined (MY_WORKSPACES_LOCATION) && exists ($(MY_WORKSPACES_LOCATION))
    _USTN_WORKSPACESROOT                        = $(MY_WORKSPACES_LOCATION)
%endif
#------------------------------------------------------------------------------
```

   - The workset will automatically be redirected to the same shared network location as the workspace.

3. To change the workspace to a shared network drive and store the workset in a **different** location, follow the steps below:
   o Under the **WorkSpace Standard Location**, change the code in the box below to point to the folder location that will contain the **TDOT_Standards** folder and **TDOT_Standards.cfg** file. Uncomment the line (e.g., remove the **#** at the beginning of the line) to redirect the code to this shared network location (Figure 2 on the previous page).
   o The workset location must also be changed to the different location than the workspace under the **WorkSet Standard Location**. Change the code in the box below to point to the folder location that will contain the workset folders, .cfg files, and the .dgnws files. Uncomment the line (e.g., remove the **#** at the beginning of the line) to redirect the code to this other shared network location (Figure 3).

FIGURE 3. WORKSET STANDARD LOCATION


```
#==============================================================================
# WorkSet Standard Location
#==============================================================================
# WorkSet standards are extensions or overlays to a WorkSpace standard.
# A common use for WorkSet standards is for project specific standards and data.
# Organization + WorkSpace + WorkSet = OpenRoads Designer Environment
#
# By default WorkSets are children of WorkSpaces and are stored in
# a sub folder of the WorkSpace. In other words, each WorkSpace has its
# own set of WorkSets. The default location is a sub folder named WorkSets. For example,
# \ProgramData\Bentley\OpenRoads Designer CE\Configuration\WorkSpaces\{workspace name}\WorkSets\
#
# If the WorkSpace is redirected to the network using the MY_WORKSPACES_LOCATION
# variable as described in the previous section, the WorkSet is automatically
# redirected to that same network location and no changes are needed in this section.
#
# If you choose to store the WorkSet in a different network location from
# the WorkSpace standards, this section should be used. When WorkSets are
# stored at a different network location than the WorkSpace, they are still
# a child of the WorkSpace and they must still be organized with parent folders
# named the same as the WorkSpace. These folders must be created manually.
# Optionally the WorkSets could be stored in a separate folder from the WorkSpace
# but be aware that this can cause users confusion because it is possible to create
# new files in a WorkSet (project) using incorrect WorkSpace standards. To use this
# optional method storing WorkSpaces and WorkSets in separate folders, uncomment the
# _USTN_WORKSETSROOT = $(MY_WORKSET_LOCATION)/ line below and deleted or commented
# out the line above it.
#
# To redirect to a network location, uncomment the MY_WORKSET_LOCATION line and
# replace the network path with your network path. This is the root path
# where the WorkSets are located and does not include the required
# WorkSpace folders that must be created manually.
#
# <<<< Make Changes Here >>>>
# MY_WORKSET_LOCATION = //MyNetwork/MyWorkSpaces/
```

The **TDOT_Standards** folder will need to be housed under the shared network drive location for the worksets. Within the TDOT_Standards folder is the subfolder that will contain the worksets. The worksets folder will contain all the worksets and associated files that have an identical structure to what is currently on the **C:** drive (Your_Shared_Drive\...\TDOT_Standards\WorkSets).

2.1.2 Creating a Custom Configuration on a Shared Network Drive

Additionally, some consultants will want to set up a custom configuration on a shared network drive. The following describes the steps needed to implement this approach.

For the following example, the steps previously outlined for creating a workspace and a workset on a shared network drive will also need to be completed.

1. Under the main configuration folder, open the **ConfigurationSetup.cfg** file.

2. To change the configuration to a custom configuration on a shared network drive, follow the steps below:

   o Under the **[General]** section, change the code in the box below to point to the location of the **Custom Configuration** (similar to the highlighted example in the code instructions) (Figure 4).

   FIGURE 4. CUSTOM CONFIGURATION LOCATION

```
#----------------------------------------------------------------------
#  ConfigurationSetup.cfg - Configures the root Configuration directory
#  for Your Organization
#
# The main function of this configuration file is to allow user to specify
# the root Configuration directory to activate. The active Configuration
# directory is represented by _USTN_CONFIGURATION. By default, it points to
# the installed Configuration defined by _USTN_INSTALLED_CONFIGURATION,
# which can consist of example WorkSpaces and WorkSets.
# If your organization has its own Configuration directory, you can define
# _USTN_CUSTOM_CONFIGURATION to that directory path and use it as follows.
#
#_USTN_CUSTOM_CONFIGURATION = D:/.../MyConfiguration/
#_USTN_CONFIGURATION : ${_USTN_CUSTOM_CONFIGURATION}
#----------------------------------------------------------------------


#----------------------------------------------------------------------
# START: The section defines user selection at the time of installation.
# These lines are generated by installer.
[General]
_USTN_USER_CONFIGURATION_LABEL=
_USTN_CUSTOM_CONFIGURATION=

[SetConfiguration]
%if !defined (_USTN_USER_CONFIGURATION)
%if defined (_USTN_CUSTOM_CONFIGURATION) && ($(_USTN_CUSTOM_CONFIGURATION) !=
_USTN_CONFIGURATION = $(_USTN_INSTALLED_CONFIGURATION)
%endif
%endif
```

o Under the **[General]** section, a custom label can be added in the box below to override the generic **Custom Configuration** label displayed in the workspace drop-down. This is an optional customization piece available in the code (Figure 5).

FIGURE 5. CUSTOM CONFIGURATION LABEL

```
#----------------------------------------------------------------------
#  ConfigurationSetup.cfg - Configures the root Configuration directory
#  for Your Organization
#
# The main function of this configuration file is to allow user to specify
# the root Configuration directory to activate. The active Configuration
# directory is represented by _USTN_CONFIGURATION. By default, it points to
# the installed Configuration defined by _USTN_INSTALLED_CONFIGURATION,
# which can consist of example WorkSpaces and WorkSets.
# If your organization has its own Configuration directory, you can define
# _USTN_CUSTOM_CONFIGURATION to that directory path and use it as follows.
#
#_USTN_CUSTOM_CONFIGURATION = D:/.../MyConfiguration/
#_USTN_CONFIGURATION : ${_USTN_CUSTOM_CONFIGURATION}
#----------------------------------------------------------------------


#----------------------------------------------------------------------
# START: The section defines user selection at the time of installation.
# These lines are generated by installer.
[General]
_USTN_USER_CONFIGURATION_LABEL=
_USTN_CUSTOM_CONFIGURATION=

[SetConfiguration]
%if !defined (_USTN_USER_CONFIGURATION)
%if defined (_USTN_CUSTOM_CONFIGURATION) && ($(_USTN_CUSTOM_CONFIGURATION) !=
_USTN_CONFIGURATION = $(_USTN_INSTALLED_CONFIGURATION)
%endif
%endif
```

Take Note!

Bentley has a Configuration Tips communities page that might be helpful to make sure your configuration setup file has the correct variables.

2.2 Deployment of ORD Software Updates

Bentley will release an annual *major* software release, at a minimum, for ORD CONNECT Edition. There will likely be at least one (1) *minor* release as well throughout a given year. **TDOT will evaluate each release to determine whether there is value and/or a need to upgrade**. The update will be a coordinated effort between TDOT's Information Technology (IT) Division and Production Support within the Engineering Division in order to develop and prepare a deployment package. Below are a few important questions that TDOT will consider when evaluating each Bentley release:

- Does the release fix issues that are hindering the design process and/or design projects?

- Does TDOT CADD Support have adequate time to thoroughly test each release? Each release should be tested using a consistent check list and data set to confirm whether previous issues have been resolved. If issues still persist, new defects will need to be reported to Bentley. (With each new release, Bentley provides a summary of updates.[2])

- Does TDOT's IT Division have the resources to deploy a package before the next release comes out?

- Does the release require any updates to the training materials? If so, what is the level of effort to update and distribute the new training material?

Once these questions have been evaluated, TDOT can then make an educated decision on whether to deploy the release. Regardless of how many Bentley releases there are each year, TDOT will update the ORD CONNECT Edition software on an annual basis, at a minimum. A consistent annual deployment allows the TDOT CADD and IT staff to plan for the deployment and allows project development staff and consultants to plan accordingly for projects.

2.2.1 Managing a Workspace

If a survey model was created in an older version of ORD relative to what the designer is using, TDOT recommends not to uplift all surveys by default. If surveys have officially been reviewed via TDOT's QA/QC process, there is some risk, and no guarantee that the uplifting process will not fundamentally change an aspect of the survey. However, the Department does expect that Design will use the latest available ORD version. Reference the **Survey and Design ORD Versioning Guidance** document on the TDOT CADD Support website under **ORD Resources >> Requirements and Guidelines**, which provides insight on ORD versioning guidance and best practices to address when two different ORD versions are used across disciplines.

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[2] "OpenRoads Designer Readme – "What's New" *Bentley (Updated April 12, 2023),* https://docs.bentley.com/LiveContent/web/OpenRoads%20Designer%20Readme-v17/en/GUID-43563D21-2E4C-4133-AB04-26E6A4F630EB.html

2.2.2 The Civil File Manager: Converting Files Across Schemas

When upgrading a batch of files from one schema to a newer one, opening each file may not be the best option. The **Civil File Manager** is an ORD tool that allows files to be mass updated to the latest software version.

1. Open the **CivilFileManager.exe**. A user can access the Civil File Manager using the following paths:
   - **C:\Program Files\Bentley\OpenRoads Designer XX\OpenRoads Designer**
   - Within ORD, go to **File >> Civil Tools >> Civil File Manager**.
2. Run the **Upgrade All** or **Upgrade All (Force)** tool located under the **Action** tab.
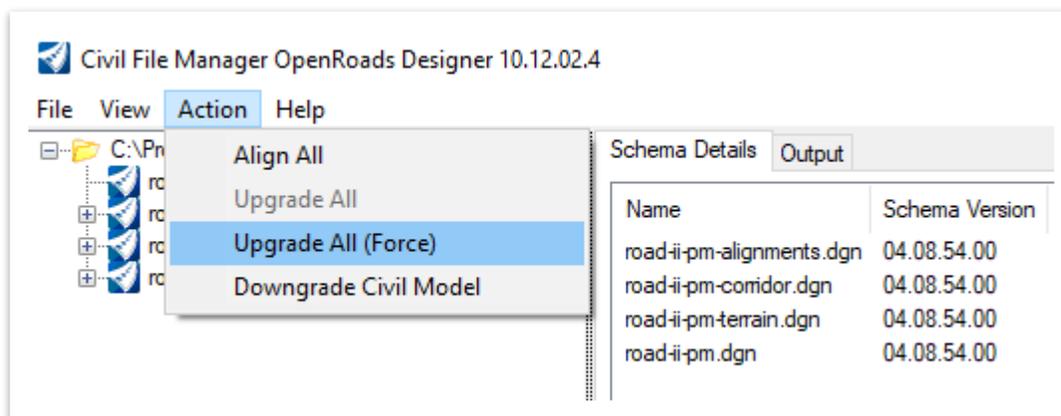
2.2.3 The Version Checker

The TDOT ORD workspace includes a **TDOT Resources** group within the **Help** tab under most workflows (Figure 6). Within the group is the **Version Checker**, which indicates the installed workspace version and compares it to the software version that is currently opened. The **Seed File Date** and **Seed File Version** item types still exist in each seed file to assist with tracking versions. They can be accessed by going to **File >> Properties**. Other tools include the **ORD Resources**, **Standard Drawings**, and **Pay Items** icons which link directly to the applicable TDOT website.

FIGURE 6. TDOT RESOURCES + VERSION CHECKER
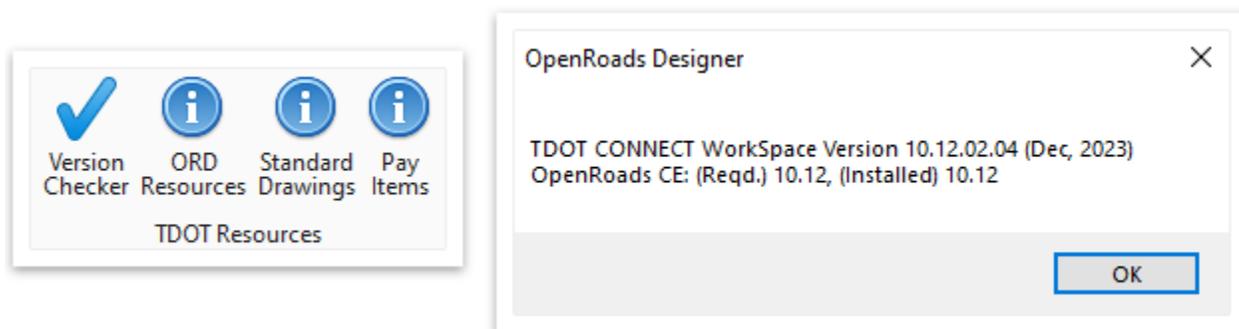
Chapter 3. Model-Based Design

3.1 Creating a Set of Plans in ORD

Overall, there will be six (6) TDOT-specific ORD training manuals that are continuing to be revised and/or developed based on the latest software and workspace advancements. These training materials focus on a specific functional area of project development. Holistically, the manuals cover modeling capabilities and the how-to of operating the new software.

The following sections are intended to provide guidance on specific means, methods, and best practices to successfully create a TDOT-specific set of plans. It should be noted that the look and feel of plans produced in ORD will differ compared to plans generated via GEOPAK. Although most alterations are minor, designers, design managers, and reviewers should be aware of the new look that TDOT plans will inherit. As the new standardization of TDOT plans production evolves within ORD, TDOT will educate and raise awareness of these "new standards" to users.

Lastly, the TDOT ORD File Naming Convention Standards should serve as a resource for plans production. It is intended to work in conjunction with this section to provide the knowledge designers need to successfully create a TDOT set of plans. Utilization of these standards will ensure that designers have implemented the revised TDOT CADD standards for file naming and structure, thus aligning with the new ORD workflows.

3.1.1 DGN Files

All **DGN** ORD file names shall follow the preset project file naming convention standards. For STID, the file naming convention begins with the project's **PIN** number. For Survey and Design, the file naming convention begins with the **2-digit county** number and aligns with the state project number formatting guidance. A few file name examples are listed below for quick reference:

- nnnnnn-nn-STID-Proposed.dgn
- 58S028-01-SUR-Model.dgn
- 58S028-DES-Corridor.dgn
- 58S028-SHT-EPSC-III.dgn

Take Note!

*Moving forward within the following steps, there will be references to file names. The **project name** portion of the file name (**58S028** in the above examples) will be removed in order to reduce redundancy.*

3.1.2 Sheet Files

Sheet files and plans production in ORD have changed significantly. Designers will no longer create individual **SHT** files. Also, printing is no longer performed from the Design model space. To fully capitalize on ORD's sheet indexing and linked annotation, designers will now have a **Drawing Model** space and a **Sheet Model** space.

- **Drawing Model:** A model space with a grey background that has the design files referenced and clipped by the named boundary. This is essentially an isolation of the applicable sheet in a design model in which a user can make changes. Match lines are stored in this model space, and in the case of profile and cross sections, annotation is placed and stored as well.

- **Sheet Model:** A model space with a white background that has a default paper size and sheet border loaded from the selected sheet seed. This model space is where the **sheet** resides and is what would be added to the sheet index. The sheet is true paper size (**34"x22"** for all seeds except the **Permit Letter** sheet seed). Only the sheet border elements (e.g., the sheet title text) should be added/edited in this model space. All other adjustments should either be made in the Design model (plan view sheets) or the Drawing model (profile and cross section sheets).

Multiple Drawing Models and Sheet Models will be grouped together in like files. For example, all **ROW Details** sheets will be in a single file. To indicate whether a file contains a sheet or sheets, the designation **SHT** will replace **DES** in the file name. An example of this naming convention would be **SHT-ROW Details.dgn**.

These **SHT** files will largely serve as a **Motif** file. The required reference files should be attached to the design model space, and then the applicable level filter should be applied to override any level display variance from the reference files. The drawing models and sheet models are then created from this design model space.

Take Note!

*Designers may need to turn off additional levels in the Sheet model, such as the **Revision Text** level.*

3.2 Design File Sequence Overview

Every design is different, yet every project follows the same file creation sequence to create an overall set of plans. Designers should create the design files per the overarching sequence shown below.

- **Step 1:** Receive and Review Survey Deliverables
- **Step 2:** Create Proposed Alignments
- **Step 3:** Create Plan View Named Boundaries

- **Step 4:** Create Core Sheet Files
  - Sheet file(s) for Present Layout(s) and Proposed Profile(s)
- **Step 5:** Corridor Modeling and Design Elements
  - Including but not limited to: Proposed Corridors, Proposed ROW Lines, Superelevation, Proposed Terrains, Earthwork, Civil Cells, Drainage Modeling, etc.
- **Step 6:** Incorporate Design into Core Sheets
  - Design component added to Present / ROW / Proposed Layout(s) Sheet(s) and Proposed Profile(s) Sheet(s)
- **Step 7:** Create Secondary Sheet Files
  - Including but not limited to: Signature Sheet(s), Title Sheet, Notes and Quantities, Typical Section(s), Detail Sheet(s), Plan Views, Profile Views, Culvert Section(s), Sign Schedule and Sign Structures, Cross Sections, etc.

Take Note!

*Throughout this chapter, direction to turn on/off Live Nesting will be discussed. A referenced attachment with **Live Nesting** turned **on** means the hierarchical structure of any nested reference are maintained when attaching the parent reference to a model. To attach a reference with Live Nesting, open the **References** tool and attach the desired reference as **Coincident-World**. Double click the reference file name to open the **Attachment Properties** and change the **Nested Attachments** drop-down to select **Live Nesting** (Figure 7). To turn off Live Nesting, return to the Attachment Properties and adjust the Nested Attachments drop-down to select **No Nesting**.*

FIGURE 7. ATTACHMENT PROPERTIES
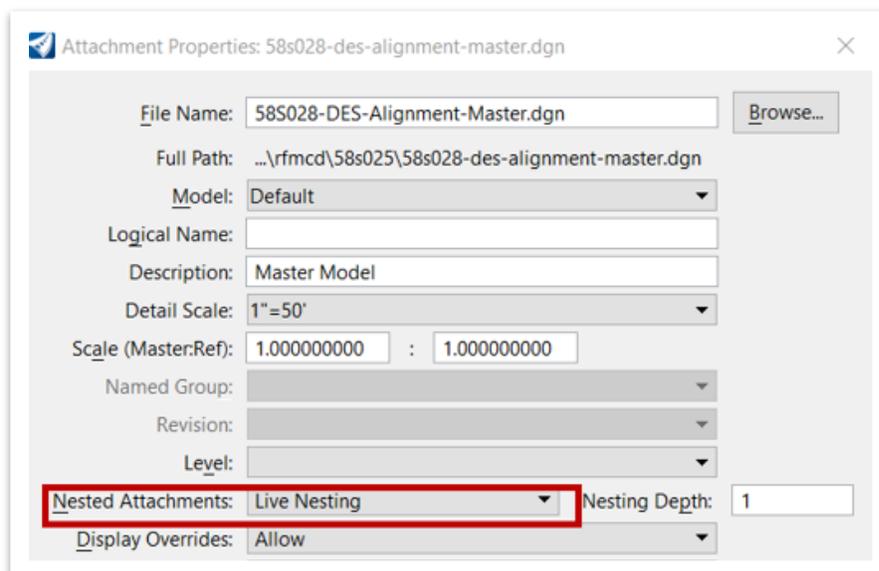
3.3 Step 1: Receive and Review Survey Deliverables

As noted in previous sections, survey staff are required to provide up to five (5) ORD deliverables:

- SUR-Aerial Model.dgn
- SUR-Alignment.dgn
- SUR-Model.dgn
- SUR-Terrain.dgn
- SUR-Utility.dgn

> **Take Note!** *For more information regarding the content of each deliverable, refer to Section 1.4.*

Throughout the life of a project, designers are going to have to adjust the survey file to make corrections, such as text overlaps or text rotation once the plan sheets are created. Before making any of these changes, designers should save the original version of all survey files in a folder marked with the original date received.

It is recommended to attach the three (3) survey deliverables (SUR-Terrain, SUR-Alignment, SUR-Utility) to the overall **SUR-Model** file. The SUR-Aerial Model may also be attached to the overall **SUR-Model** file, if applicable. This will make it easier to reference survey data when creating sheets.

3.4 Step 2: Create Proposed Alignments

Proposed horizontal and vertical alignments should be saved in an alignment file named **DES-Alignments**. If the project is large and/or complex and the designer feels it is warranted, then each proposed alignment can have its own file with a **"-Roadway Name"** to define which alignment is in that file. An example of this is **DES-Alignments-*SR1*.dgn**.

The software allows the user to draw multiple vertical alignments for a given horizontal alignment, but only one can be active at a time. If other alignments are stored in the view, they cannot be hidden unless the applicable levels are turned off or changed. If an alignment needs to be stored outside of the file, the user should export the alignment to a **LandXML** file. If a different profile/alignment is needed due to design changes, the LandXML should then be re-imported into the alignment file.

All begin/end project labels, intersection labels, stationing, and curve text should be placed in a separate file named **DES-Alignments-Text**. This file should have a minimum of two (2) design model spaces within it – one (1) for **50** scale annotation and one (1) for **200** scale annotation. In each model space, all **DES-Alignments** files should be referenced so that they all can be annotated in a single file. If necessary, the alignment text files could be broken up to match with the separate alignment files.

There are settings on alignment annotation that allow the text to hold in place relative to the alignment, or fixed if a change in the alignment is made. Special attention should be given to these settings when text is moved.

Lastly, designers will create the Alignments Master file, which should be named **DES-Alignments-Master** and will contain the references of all alignment files and the alignment text file. Create the **Alignments-Master** file using the **TDOTSeed2D**. This file should have a minimum of two (2) design model spaces within it – one (1) for **50** scale annotation and one (1) for 200 scale annotation. When referencing the Alignments-Master file, designers should reference the **DES-Alignments-Master** file and turn on **Live Nesting** to display the roadway alignments and alignments annotation utilizing a single reference file.

When referencing a **Master** file, designers should <u>always</u> have **Live Nesting** turned **on**. A master file should not contain any active elements but rather bring together all sub files of that overall file category. However, the individual files that make up a Master file should have **Live Nesting** turned **off**. Master files should be created from the **TDOTSeed2D**. If a 3D model is needed, set the survey terrain in the file to active.

3.5 Step 3: Create Plan View Named Boundaries

In ORD, **Named Boundaries** replace what was traditionally referred to as Sheet Layouts or Clip Shapes and enable the creation of plan, profile, and cross section sheets.

For plan views, designers should create a new file called **DES-NB-Plan** and reference in the **Alignments Master** file with **Live Nesting** turned **on**.

Designers should then reference Lecture 10.4 in the [Fundamentals (ORD) Manual](). Users will most likely want to set the **Boundary Chords** value to **1.** The boundary chord control is essentially the number of vertices along the top and bottom of the named boundary (e.g., a chord value of 10 would mean the boundary would more accurately curve along the alignment in a curved section because it has more pivot points). However, plan sheets are rectangular rather than curved, so the boundaries need to reflect that for the sheet views to be placed correctly without the need for adjustments.

Designers should <u>not</u> select **Create Drawing** when creating the named boundaries within the named boundaries file. This is contrary to the workflow described in Lecture 10.4 in the [Fundamentals (ORD) Manual](). Designers will create the drawings (e.g., sheets) later inside the applicable motif files rather than in the named boundaries file. If users do accidentally create sheets with these named boundaries, they will not be able to create sheets in other files.

If a project requires adjustments to the named boundaries drawn by the software, like insets, matchlines on the top or bottom of mainline sheets, or any other adjustment, then designers can make these adjustments at this time, if possible. Most adjustments such as insets and matchline naming will be made after the present layout sheets are created. Use the **DES - SCRATCH - User 1** level to draw any lines that will assist in adjusting the named boundaries. To add points to the named boundary, use the **Insert Vertex** tool on the named boundary shape. Profile named boundaries must be placed in the file that the sheets are created in as described in Lecture 8.2 in the Roadway Design I (ORD) Manual.

Likewise, cross section named boundaries must be placed in the file that the sheets are created in as described in Lecture 8.6 in the Roadway Design I (ORD) Manual. Additional insight on the setup and purpose of sheet files will be covered in the Section 3.6 and Section 3.9 of this document.

3.6 Step 4: Create Core Sheet Files

3.6.1 Sheet File(s) for Present Layout(s)

The first plan sheets a designer should create are the present layouts. To do this, designers should create a file named **SHT-Present Layout**. At a minimum, designers should reference the **SUR-Alignment**, **SUR-Model**, **DES-Alignments-Master**, and **DES-NB-Plan** files. The alignments master file should have **Live Nesting** turned **on**. The designer should then apply the **Sheets - Present Layout** level filter to the design model space. Then, designers will open the Named Boundaries toolbox and locate their plan view named boundary group that is stored in the file **DES-NB-Plan** file. Select all the plan sheets, right click, and select **Create Plan Drawing**. This will create sheet and drawing model spaces, as well as sheet layouts for all the sheets in the selection. These sheets will now be stored in this **SHT** dgn file as intended. After the present layout sheets are created, the designer will create insets and rename/make sure matchlines are correct. This present layout sheet file is now the basis for which all other plan view sheets are created from so that the matchlines are consistent.

Take Note!	***Drawing** model and **Sheet** model names only matter to the designer. They will not affect the annotation of the sheet because the software will pull the sheet number assigned in the ORD sheet index. It is recommended that designers take time to name their sheet models and sheet layouts appropriately, for easy identification (e.g., 4, 4 [sheet], 5, 5 [sheet] or Plan 1, Plan 1 [sheet], Plan 2, Plan 2 [sheet]). If additional changes are made to the named boundary after the sheets are created, the matchlines will not be in the correct location and re-annotating them will not fix the issue. The matchlines will need to be manually moved. Be cognizant that the Drawing model reference will shift within the Drawing model to try and stay in the center of the sheet.*

In the **SHT-Present Layouts** file, designers should open the sheet index for editing. Open the **Models** window and drag all the **[sheet]** models into the applicable sheet index folder. For present layout sheets, the folder is called **Present Layout(s)**. Once the sheet layouts are associated with this folder, they will automatically be numbered according to TDOT standards starting with number **4**. To synchronize the matchline text and the sheet numbers with the number automatically assigned in the sheet index, designers should open a drawing model for one of the sheets and use the **Remove Drawing Model Annotations** tool and remove the annotations for all models. Then use the **Annotate Drawing Model** tool to re-annotate all drawing models with correct sheet numbering.

> **Take Note!**
>
> *If matchlines were moved, re-annotating will move them back to their original positions. All sheets should be reviewed to ensure the correct title, number, and levels are shown. Also, changing sheet model names after linking the models to the index will drop the link. The models will then have to be re-linked to the sheet index.*

3.6.2 Sheet File(s) for Proposed Profile(s)

First, designers need to create the proposed profile sheets file named **SHT-Proposed Profiles**. At a minimum, designers should reference the alignments master file. It is recommended to create the mainline profile sheets first and then the side road profile sheets. Refer to [Section 3.9.7](#) for private drive profile sheet creation. The designer can choose whether the profile sheets are broken into multiple files for the mainline, side roads, and private drives for better management. Designers will then open the mainline profile view and create named boundaries.

The stationing and length of the profile sheets should match that of the plan views they are associated with. Designers can select **Create Drawing** before exiting the named boundary tool, if desired, to create the drawing and sheet models in one click. Once the sheets are created, the vertical alignments will be annotated automatically.

All profile annotation should occur in the profile **drawing** models as Profile Views in the design model are dynamic and should not be annotated. Designers should now place all project information annotation (begin/end const., intersection callouts, etc.) manually in the applicable drawing models.

> **Take Note!**
>
> *This workflow addresses the initial sheet creation. Refer to [Section 3.9.7](#) for integration of existing and proposed drainage and utilities onto profile views.*

Side road profiles will fall into two (2) categories:

1. Significant side road profiles that take up an entire profile sheet(s).
2. Minor side road profiles that take up less than one sheet and could easily be combined with other side road profiles onto a single sheet.

For #1, follow the above workflow to create the proposed side road profile sheets. For #2, designers should refer to Section 3.9.7 to place multiple profiles on a single sheet in ORD.

3.7 Step 5: Corridor Modeling and Design

3.7.1 Proposed Corridors

Each roadway in the design should have a separate corridor file and separate **CTRL** files. The CTRL files should be named **DES-Corridor CTRL-Road Name**. These files are allocated for designers who chose to control a corridor or parts of a corridor based on linear elements. Naming of control points should follow a naming convention that is easy to follow and clearly identifies the point being controlled. The **Project Notebook** should state how the corridors are controlled. (Refer to Section 5.3.1 for more information.).

All proposed plan view roadway text, excluding project information text that is included in the DES-Alignments-Text file, should be placed in a file named **DES-Corridor-Text**. At a minimum, this file should have all proposed corridors and the plan view named boundary file referenced to allow proper text rotation. The corridor text **files** will contain all roadway related labeling for the proposed corridor. This file should not include ROW, EPSC, pavement markings or other labels that are better stored in other design or design text files.

A corridor master file named **DES-Corridor-Master** should be used to bring together all corridors, proposed text, and proposed design elements, including bridges, drainage structures, pavement marking etc., into a single file that can be referenced. This file takes the place of the traditional **Proposed** file.

When developing corridors, it is not recommended to use nested references as base files. For example, the mainline corridor should be built upon the **DES-Alignments** file, and not the **DES-Alignments-Master** file. The same considerations should be made for creating corridor control elements and surveyed terrains. This is not a requirement but may make file management easier to understand and may reduce accidently removing nested files if detaching references. **Nested Files** are helpful for plan production and to quicky be able to view multiple files but should not be used to build upon for a design.

Modeling corridors can create large files, so it is important to evaluate the size of a project which is dependent on the model detail and the necessary density. For projects that have a long corridor, it is recommended to break up the mainline into multiple corridor files. A good rule of thumb is if the corridor is over a mile long, you should create multiple corridor files. If the corridor is dense, however, you may want to use a smaller metric.

> *When creating a copy of a workset with files containing a corridor file, an archived corridor file will be created and will be difficult to remove. The archived corridor will result in duplicate quantities at the minimum. The workaround is to create a copy of the corridor and then detach the archived model from the references. It is not recommended to create a workset from an existing project workset with files.*

Take Note!

3.7.2 Proposed Template Library

Most design elements will require a template (i.e., a corridor, linear template, or surface template). The TDOT ORD workspace comes with a template library (**Civil Templates-TDOT.ITL**) that has many pre-built templates for different requirements. However, it is impossible to include all scenarios within this template library. Designers will need to customize their templates for each corridor that is created. The first step would be to copy the latest TDOT ITL file from the delivered workspace and place it in the project workspace for the team to access. Even if utilized templates are not modified, it is recommended to store them in the **TDOT Project Templates** folder in the project specific ITL. This workflow allows users to easily reference the default TDOT templates when modifying them.

It is also recommended that designers follow the naming conventions that have been set up in the TDOT ITL file when creating custom templates. Refer to the TDOT Template Library and Points Name document for more information on point and component naming.

3.7.3 Proposed ROW Lines

ROW details are mostly comprised of annotation, labeling, and patterning. Refer to Chapter 6 and Chapter 9 in the Fundamentals (ORD) Manual and Lecture 5.5 and Appendix A.6 in the Roadway Design I (ORD) Manual for specific tools needed to generate these details. In general, designers will need to select the appropriate element template before selecting a pattern. The element templates will have the correct level symbology and pattern associated with it. For labeling, the **Civil Labeler** already has many ROW labels setup with the correct symbology.

To place existing or proposed ROW annotation onto the XS sheets, designers need to assign the existing ground profile as the active profile to the ROW linework. For proposed ROW lines, this can be placed in the **DES-ROW** file. For existing ROW lines, designers can go into the **SUR-Model** file or copies of the required linework can be created and placed in the **DES-ROW** file. If the ROW linework has an active profile along the entire element and the correct feature definition, the annotation will place with the rest of the XS annotation.

To create and store acquisition shapes, create a new file named **DES-ROW-Acquisition Shapes**. Refer to Appendix A.7 in the Roadway Design I (ORD) Manual for the process to place points, store dynamic shapes, and create reports for acquisitions on a project.

These shapes will not be plotted on plans and are for the designer's use only to create other documents and have a standard symbology and location where acquisition shapes are stored.

Take Note!

3.7.4 Superelevation

Each roadway in the design should have a separate superelevation file. After creating a superelevation file for each roadway, designers should create a superelevation master file named **DES-Superelevation-Master**, using the **TDOTSeed2D.dgn**, that contains all the superelevation files as references. The superelevation should be assigned to corridors in each of their respective files and not in the corridor master file.

When creating the superelevation section, select the **alignment** as the base (<u>**not the corridor**</u>). If the corridor is selected, then the diagram will not place in profile view. The diagram will only place on the alignment that is selected when the superelevation section is created. To place a superelevation diagram in profile sheets, select the Drawing Model Annotation group **Superelevation Diagram**. Any changes to the superelevation will require the annotation to be re-annotated.

Note: For alignments with more than one superelevation section, each with individual superelevation rules, only one (1) superelevation section can be used for automatic annotation on a sheet. The other superelevation section(s) on that sheet will be unable to be automatically annotated.

For alignments with more than one superelevation section, each with individual superelevation rules, only one (1) superelevation section can be used for automatic annotation on a sheet. The other superelevation section(s) on that sheet will be unable to be automatically annotated.

Take Note!

3.7.5 Proposed Terrains

In ORD, designers are required to deliver the Design **Proposed Finish Grade** (PFG) at a minimum. This should be performed for each individual corridor and should be named **DES-Terrain-PFG-Road Name**. Designers are also required to create a design PFG master terrain that is either a complex terrain from the individual corridor terrains, or a single terrain created from the **DES-Corridor-Master** file.

These terrains can be created in two ways: (1) By using the **Graphical Filter** tool, which uses the 3D lines of a corridor and a list of feature definitions to create a terrain, or (2) By using the **Create Terrain Model From Design Meshes**, which might be most useful when creating the PFG terrain.

> *Optionally, designers may choose to provide the Design **Grading Surface** (GS), Design **Paving Surface** (PS), and/or the Design **Roadway Surface** (RS) for the proposed model. These other surfaces can provide additional value to the contractor for automated machine guidance. These are not required by TDOT as deliverables at this time unless otherwise stated in the contract for the project. Refer to Section 5.2.1 for more detail on the different surfaces.*
>
> **Take Note!**

3.7.6 Earthwork

Earthwork workflows will continue to evolve as the software advances. For now, the series of steps designers will need to perform to calculate earthwork is explained below.

First, designers will need to make an earthwork file for each corridor. These files will use the following naming convention: **DES-Earthwork-Road Name**. In each file, designers will run the earthwork workflow described in Lecture 8.4 in the Roadway Design II (ORD) Manual. Earthwork in ORD runs a **volumetric** method that calculates the true cut-fill volumes of the model. This results in a more accurate calculation but also means there is a lot more processing that needs to be performed. Separating the corridor calculations goes a long way to making this process manageable. All the separate corridor earthwork calculations and shapes should be referenced into a master file, which should be named **DES-Earthwork-Master**. In the future, these **DGN** design files will be delivered to contractors but marked as **for information only**.

For more complicated earthwork that includes topsoil and existing pavement, an additional corridor will need to be created named **DES-Corridor-Existing-Road Name**. It is important to set up this file before conducting any earthwork. It will be beneficial to split the existing corridor at the same plan location as the proposed corridors are split (at side road EOP's, change in corridor files, etc.). This includes turning the topsoil off at proposed side roads. This workflow allows for more accurate earthwork and cleaner breaks when combining each earthwork file into the master file.

> *It is not recommended to run earthwork calculations for nested files. It is recommended that the earthwork calculations only be run on a single corridor at a time.*
>
> **Take Note!**

For the earthwork calculations that are shown in the plans, the **Average End Area** method will be used. Reference the earthwork file that corresponds with the XS file and then select the **End Area Volumes Report** tool. Running this report will generate an **EAV Report** that is linked to the cross section named boundaries. Users can then utilize the **XS EAV Table** or **XS EAV Table - No Volume** drawing annotation to automatically populate the cut/fill values on cross sections. The EAV Report can also be used for developing the **Estimated Grading Quantities**.

3.7.7 Civil Cells

TDOT utilizes a library of custom-built civil cells to make complex modeling situations easier and faster for the average user. These cells also help provide consistency across the regions so that TDOT designs are the same throughout the state and meet TDOT standards. Complex modeling situations such as driveways, curb ramps, and intersections are all intended to use the applicable TDOT civil cell.

Civil cells are dense objects when inserted into a file and can significantly slow the file speed down, especially if there are multiple civil cells in a single file. For this reason, it is recommended that all side road intersection civil cells are in the **DES-Corridor-Road Name** file that contains the applicable side road. It is also recommended to not place driveway and curb ramp civil cells in the early stages of a project, since design changes can easily break these civil cells and will require them to be modeled again. For driveways, it may be beneficial to have those civil cells in their own file (**DES-Corridor-Driveways**). Ultimately, it is up to the designer how best to organize the modeling depending on the file size of the project extent.

Civil cells are limited and not all civil cells will work in all scenarios. In some cases, designers will have to utilize the provided TDOT civil cells as a starting point or use ORD modeling skills to model the scenario manually. It is not required to utilize civil cells on a project, but it is recommended for the complex modeling situations (e.g., curb ramps).

Take Note!

On the TDOT website, there is an ORD Civil Cell Tips and Videos page. Designers can reference training videos that walk through the placement of each custom-built civil cell in the TDOT ORD workspace as well as documents outlining tips and tricks for designing with civil cells and modeling roundabouts.

3.7.8 Drainage Modeling

The SUDA (ORD) Manual provides information on the Drainage and Utilities tools needed to design a drainage model in ORD. All hydraulic calculations, as well as existing and proposed structures to remain, should be placed in the file named **DES-Drainage-Hydraulic Model**. The hydraulic analysis for box culverts and slab bridges will also be in this file. This is required as the Drainage and Utilities software will only allow one (1) model in each design file. Also, the Drainage and Utilities file can only have one (1) user working in the file at a time, so large projects will need to be divided into smaller design files. The 3D model for box culverts and slab bridges should be in the **DES-Drainage-Structures Model** file and will be modeled with linear templates. For any temporary hydraulic calculations done for construction phasing or EPSC, these would be contained in the **DES-Drainage-Temp Hydraulic Model** file. If any modeling is required for stream relocations, the model will be developed in a separate file named **DES-Drainage-Stream Relocation Model**. Refer to the Roadway Design II (ORD) Manual for the tools required to model these items.

The Drainage and Utilities calculation output, also known as the **flex table**, should be named **PRJ Name-DES-FlexTables_IntensityYR_A.xls** (i.e., PRJ NAME _Flextable_10 YR_A.xls). Although ORD has other Bentley products available to be utilized such as Storm CAD, CivilStorm, SewerCAD, and SewerGEMS, the user will need to make sure and pick the license that is needed and then deactivate the license when finished. There are limited licenses for the previously listed software, so if the user does not deactivate, the license will not be released for availability for another user to access what is needed. The user will need to open the Bentley licensing tool and check in the license to release it back into the system.

Profile drainage design and annotation should also be done in the **DES-Drainage-Hydraulic Model** file. Unfortunately, profile views or named boundaries cannot be referenced into each other at this time, so be careful when preparing the profile view named boundaries of drainage systems that are parallel to a roadway alignment, and make sure they match those created in the core sheet files. When designers are creating named boundaries, they should select **Create Drawing** before exiting the named boundary tool to create the drawing and sheet models in one click. The **drawing models** created during this procedure are going to be referenced into the **SHT-Proposed Profiles** file in order to get the drainage annotation onto the proposed profile sheets. The **sheet models** created during this procedure should now be deleted. These sheet models need to be deleted to reduce confusion of the most up-to-date data that should be used for the deliverable. <u>Do not delete the drawing models</u>. All existing and proposed drainage annotation marked **to remain** should be in the applicable drawing models of the **DES-Drainage-Hydraulic Model** file.

To insert Special Ditches into a profile, it is recommended that the proposed profile be drawn in the **DES-Alignments** file (the same location the proposed alignment is located). This will allow the automatic annotation set up to annotate the proposed profile. This alignment will need to be drawn, and not projected, as projected profiles are linestrings with many vertices and the annotation will not be able to properly annotate. To use the proper annotation group, the user will need to override the annotation group and select the proper annotation. This places VPI labels and a flow arrow along the drawn alignment. The user will need to use the civil labeler to place the begin/end special ditch labels.

3.7.9 Annotation

The types of annotation can be broken down into plan, profile, and cross section. For plan annotation, it will be contained in different dgn's and be actively referenced to **SHT** dgn's. The SHT dgn's would then be **motif** files, with no design information other than containing the Drawing and Sheet models. For profile and cross section annotation, it will be contained in the **Drawing** model that is then referenced into the appropriate sheet. Annotations have been set up in the applicable locations to assist the designer in properly annotating a project.

Linestyles and annotation that originate in ORD will automatically scale based on the selected **Drawing Scale** if the element / linestyle is set to be **Annotative**. If something is not set as annotative, it typically is meant to be placed on sheets that are **true scale**. Linestyles and annotation that originate outside ORD (e.g., an SS2 survey / project that is being brought into or converted to ORD) will need to be manually scaled if the **SS2 Standards.zip** file has not been applied.

The TDOT ORD workspace contains several different classes of automatic annotation, and this will continue to advance over time. However, different types of annotation have different placement workflows, and it is important to remember that not all annotations can be automatic. The following describes the labeling hierarchy:

1. **Drawing Model Annotation:** This tool is considered the base set up for Drawing models when annotation plans. There are several categories that cover an entire Drawing model:

   - **Plan:** Matchlines and north arrow.
   - **Profile:** Grid elements and superelevation diagrams.
   - **Cross Section:** Grids, and all automatic annotations for slope, guardrail, and ROW labels, plus the EAV tables.

2. **Element Annotation:** This tool is utilized to place the primary annotation, which has been automatically linked to the applicable **Annotation Group** so that the correct feature symbology is seen in the plan, profile, and cross section models. This tool will be the first option when annotating different elements. In addition, there are automatic annotations for alignments (horizontal and vertical), ROW, utilities, survey, cross section, etc.

3. <u>**Civil Labeler:**</u> This tool is ultimately replacing the **Place Label** tool and is used to annotate in plan, profile, and cross section models after any drawing model annotation and element annotation has been applied. The cell-based annotation labels are not being updated with the new versions of the TDOT ORD workspace and will eventually be phased out. The **Civil Labeler** provides additional automatic annotation options with the proper attributes already setup, including model properties such as stationing, northing/easting, conduit sizes, elevations, etc. **Note:** There is a software defect in **10.12** where the **Dimension Style** and **Text Style Override Symbology** settings in the Civil Labeler don't work. The user will need to manually set the proper element template and dimension style.

4. <u>**Manual Labeling:**</u> For the elements that cannot be annotated using the annotation groups or civil labeler, the user will need to manually create the labels, which is done by utilizing the **Place Note** tool. In addition, the applicable **Element Template**, **Dimension Style**, and **Text Style** will need to be selected.

For patterning, the **Pattern** cells have been linked to the applicable element templates in various folders so the correct symbology will be seen when utilizing the **Pattern Area** tool.

Note: For **profiles** and **cross sections** with differing horizontal and vertical scales, manually measuring elements in the <u>vertical</u> direction will provide incorrect values. This is because there can only be one scale, which is in the **horizontal** direction. For the vertical direction, the exaggeration will cause all **Y** direction data to be a multiple of the actual values. For example, in the **Profile 50H 5V Scale** sheet, the **1'** grid value is equal to **10'** in the **Drawing** model.

3.7.10 The Corridor Linework Display File

Modeling in ORD is controlled in the **2D** model space but is created in the **3D** space, which creates some plan production difficulties. Users will frequently clip models that intersect with each other in the 3D space. However, these clips only show up in the **3D** space and showing the same clip in the 2D space can be difficult. There are two ways to handle this:

- In the **SHT-Proposed** files, create clip fences to clip out the linework that is not desired on the plans. This can be a very labor-intensive process and is not likely the preferred option as the clips are not dynamic.

- Create an additional file named **PRJ NAME-DES-Corridor Linework Display**. This file would only contain the linework that cannot be used directly from the corridor and is mainly used for clean EOP lines through intersections. For end conditions, shoulders, curb, and sidewalk lines, reference the **3D** model lines from the **DES-Corridor-Master** file since most will be clipped correctly. This will reduce the amount of maintenance needed for the linework display file. Depending on specific design elements, it may be necessary to draw the shoulder, curb, sidewalk elements, etc (e.g., EOP lines). **Note:** This method requires additional upkeep throughout the life of a project but is the recommended method for plan production.

3.8 Step 6: Incorporate Design into Core Sheets

3.8.1 Design Components Added to Present Layout(s) Sheet(s)

The core sheets should be created before the bulk of design happens. Therefore, designers will need to reconcile design elements created after the core sheets were developed into the core sheet files. For plan views, this only requires the addition of any reference that contains elements that need to be shown. For example, in the present layout, the **DES-ROW** file will need to be referenced into the **SHT-Present Layouts** file for it to be displayed on the present layouts. After referencing new files into the design model, designers should always re-apply the applicable level filter to the design model space.

3.8.2 Design Components Added to Proposed Profile(s) Sheet(s)

Profile view sheets are more labor intensive than plan view sheets. Typical data that may need to be shown on the proposed profile sheets include existing utilities and proposed drainage. Each of these sets of information requires a separate workflow for how to get the information displayed on the proposed profile sheets.

First, the proposed drainage information will be addressed. To get the proposed drainage design and annotation into the profile, designers must first open the **SHT-Proposed Profiles** file. Then, the designer must open the first drawing model space that correlates with the profile of the first plan sheet in the design (e.g., sheet 4C). Now designers can reference the **DES-Drainage-Hydraulic Model** file into this drawing model. Change the model space of the reference to the matching drawing space in the DES-Drainage-Hydraulic Model file. The profile drawing model from the DES-Drainage-Hydraulic Model file should automatically be aligned with the active model in the **SHT-Proposed Profiles** file. If it is not, move the reference to the correct location. Repeat this process for all profile sheets that will show proposed drainage systems.

To get the existing utility information on the proposed profile, there are several factors. If the proposed alignment is the same as the surveyed alignment, then designers would open the **DES-Alignments** file (profile drawing model) and reference in the **SUR-Alignments** file (profile drawing model), which already has the existing utilities projected onto the centerline profile. Then, turn off the unnecessary levels in the reference (e.g., DES - PRO - Proposed Text).

If the proposed alignment changes from the surveyed alignment, then the designers would need to re-project the existing utilities in the **DES-Alignments** file. Attach the **SUR-Model** and re-project the non-modeled existing linear utilities (e.g., water line) and attach the **SUR-Utility** file and re-project the modeled existing linear utilities (e.g., SA line, drainage pipe). For crossing utilities (also in the SUR-Utility file), the reprojection is done via the **Create 3D Cut** tool within the dynamic profile model in the **DES-Alignment** file. If a 3D Cut boundary has previously been placed, simply use the **Refresh 3D Cut** tool and the existing utilities will appear.

3.9 Step 7: Create Secondary Sheet Files

3.9.1 Signature Sheet(s)

When creating a signature sheet, designers should use the **Signature Sheet** seed and name the file **SHT-Signature**. The signature template is placed to the left of the sheet and can be copied over and modified as needed. If a second sheet is needed, then designers should copy the first sheet model and rename it. For additional details on how to create a signature sheet, refer to Lecture 11.9 in the [Fundamentals (ORD) Manual](). After creating the sheet, designers should add the sheet model to the sheet index.

3.9.2 Title Sheet

When creating the title sheet, designers should use the **Roadway Title Sheet** seed and name the file **SHT-Title**. Utilize the title sheet level filters to adjust what is shown based on the phase of the project. For additional details on how to create a title sheet, refer to Lecture 11.2 in the [Fundamentals (ORD) Manual](). After creating the sheet, designers should add the sheet model to the sheet index.

3.9.3 Notes and Quantities

The notes and quantities sheets for are typically placed in the 2 and 3 series sheets at the front of the plan set. Occasionally, discipline-specific notes sheets are placed in that discipline's sheet number scheme (e.g., EPSC Notes). The overall methodology for creating these sheets is not dependent on where the sheet will ultimately be placed in the index. As long as the primary item shown on the sheet is a word document or excel spreadsheet, this is considered a notes and quantities sheet for the purpose of this document. Each notes category should get its own file in ORD. For example, if there are going to be three (3) general notes sheets, then all the sheets should be stored in the **SHT-General Notes** file. Special notes, however, would be in their own file named **SHT-Special Notes**. To create a notes file, designers should select the **Roadway Word** seed file. From there, Lecture 11.6 in the [Fundamentals (ORD) Manual]() instructs how to place a word document into a sheet file. Word files should be embedded in the document because they are not separate design deliverables. The methodology is the same for quantities sheets; however, the **Roadway Excel** seed file should be used. Excel files should be linked to the original document because they are a separate design deliverable. After creating all the necessary sheets, designers should add the sheet models to the sheet index and assign the correct sheet numbers.

> *Word and Excel files can be linked within the same sheet file (e.g., ROW Notes, Utility Notes, Utility Owners, and ROW Acquisition Table shown on the same sheet). The difference between the seed files associated with Word documents and seed files associated with Excel documents are their snap points. It is recommended that a designer use the seed file with the snap points that best align with the content of the sheet. The designer can then add additional information by linking or embedding either Word or Excel documentation.*

Take Note!

3.9.4 Typical Section(s)

Typical sections in ORD should utilize the **Roadway Typical Sections** seed file and be named **SHT-Typical Sections**.

This seed file has representative sheet boundaries in the design model space for up to six (6) typical section sheets. It also has six (6) sheet models pre-clipped to make the production of typical section sheets more efficient. This should be enough typical section sheets for most projects. If more sheets are needed, designers can copy the representative sheet boundaries in the design model to provide more drawing space and then copy a sheet model, adjust the reference location, and repeat the process to create as many sheets as necessary. After creating all the necessary sheets, designers should add the sheet models to the sheet index and assign the correct starting sheet number.

> *This methodology differs from that in Exercise 11.8: Create a Typical Section Sheet in the [Fundamentals (ORD) Manual](#) (November 2020). The manual will be revised to reflect this methodology.*

Take Note!

3.9.5 Detail Sheet(s)

A detail sheet is any sheet containing project-specific details (mostly manually drawn) or depictions of project scenarios. When creating these sheets, designers should use the **Roadway Blank** seed file and name it **SHT-Details**. If a discipline-specific details sheet is needed like Signal Details, the same seed file should be used to create the sheet, but the file name should include the discipline before "Details" (e.g., **SHT-Signal Details**). In all cases, this file should contain all detail sheets for that section of the plans. After creating all the necessary sheets, designers should add the sheet models to the sheet index and assign the correct starting sheet number.

3.9.6 Plan Views

Secondary plan view sheet files can be created in whatever order a designer sees fit. The total number of sheets and what is required is determined by the phase of the project. However, the steps outlined below show the general process required to create any plan view sheet that matches the scale of the present layout sheets (typically **50 scale**):

1. In File Explorer, copy the **SHT-Present Layout** file. Then, rename it to the applicable set of plan view sheets. (e.g., the ROW Details sheets). This copied file will be named **SHT-ROW Details**. Create the rest of the sheets using the present layout sheets file as a **seed**, which ensures that all view frames, matchlines, and north arrows are consistently placed across the plan set. This is especially important if any named boundary adjustments have been made.

2. Open the new file. In the drawing model space, add or delete any references, as necessary. Set the level filter for all references to the appropriate name – in this case it would be **Sheets - ROW Details**.

3. Adjust the names of the drawing and sheet models to maintain easy identifiable naming when viewed in the sheet index. This is necessary as you will not want two sheet models with the same name in the sheet index.

4. Open the sheet index for editing. Then, open the models window and drag all the **[sheet]** model spaces into the applicable folder of the sheet index. This will automatically assign sheet numbers based on TDOT standards.

   a. For sheets which are not alphanumeric off the present layout (e.g., EPSC sheets), designers will need to calculate how many total sheets will be ahead of the first sheet in the folder and manually input the first number in the folder properties. After adjusting the first sheet number in a folder, the other sheet numbers will auto-increment off that number.

5. With the sheet models associated with the correct folder in the sheet index and the correct numbers assigned, designers can correct the matchline text by removing the plan annotation in the drawing models and then re-annotating the drawing models with the correct information as described in [Section 3.6.1](#). **Note:** The matchlines will be placed at their original position and may need to be adjusted.

6. Review to ensure the correct title, number, and levels are shown on each sheet.

For **200 scale** sheets or any other scale that is not equal to that of the present layouts, designers should follow these steps:

1. Open the file **DES-NB-Plan** file. Open the model space manager and create a new model spaced named **200 scale**.

2. Set the drawing space scale to 1" = 200'.

3. Reference in the alignments master file.

4. Create named boundaries as desired. If necessary, the designer can adjust the named boundaries.

5. Create the desired sheet file. For example, Property Maps would be **SHT-Property Map**.

6. Reference the required files and then select the applicable level filter for all references. Ensure that the **DES-NB-Plan** file is referenced and set it to the **200 scale** model space.

7. Open the Named Boundaries toolbox and locate the plan view named boundary group. Select all plan sheets, right click, and select **Create Plan Drawing**.

8. Adjust the names of the drawing and sheet models to maintain easy identifiable naming when viewed in the sheet index.

9. Open the sheet index for editing. Then, open the models window and drag all the **[sheet]** model spaces into the applicable folder of the sheet index. This will automatically assign sheet numbers based on TDOT standards.

    a. For sheets which are not alphanumeric off the present layout (e.g., EPSC sheets), designers will need to calculate how many total sheets will be ahead of the first sheet in the folder and manually input the first number in the folder properties. After adjusting the first sheet number in a folder, the other sheet numbers will auto-increment off that number.

10. With the sheet models associated with the correct folder in the sheet index and the correct numbers assigned, designers can correct the matchline text by removing the plan annotation in the drawing models and then re-annotating the drawing models with the correct information as described in Section 3.6.1.

11. Review to ensure the correct title, number, and levels are shown on each sheet.

Once a set of sheets is created for that scale, it is recommended to copy that file and rename it to create the next set of sheets, as this will ensure consistency across the sheets and speed up the sheet creation process.

3.9.7 Profile Views

It may be necessary to create multiple profile sheet files, depending on the project size. For smaller projects, it is recommended at a minimum to have the mainline profile in its own sheet file, and then the side roads in their own sheet file. Designers can further break up side road profiles as necessary. It is also recommended that driveway profiles have their own sheet file. How to breakout the profile sheets is ultimately up to the designer, keeping in mind the primary considerations such as file size and file management.

Placing multiple profiles on a single sheet is labor intensive in ORD. The software does not currently support an automatic way to place multiple profiles on a sheet at one time. Examples of profile sheets that might contain more than one profile are short side road profiles and private drive profiles. The steps below explain the process as if designers are creating private drive profile sheets; however, the steps for both types of sheets are the same.

Designers should first open the **SHT-Proposed Profiles** file or applicable profile dgn sheet file. Then, designers will utilize the tools in Lecture 8.2 in the [Roadway Design I (ORD) Manual](#) to create profile named boundaries for a single driveway profile. Designers should select the drawing seed **Profile 50H 5V Scale** and shorten the length and available profile height to make a named boundary that provides enough room to capture all the information. For most driveways, the length would be 200 feet or less and 15-20 feet in height. Before accepting the named boundary, designers can select **Create Drawing** before exiting the named boundary tool, if desired, to create the drawing and sheet models in one click. After the models are created for a single driveway profile, designers should repeat the above steps for all private drive profiles.

With all private drive profile drawing models and sheets models created, designers can now work to consolidate private drives onto the minimum number of sheets. Every project is different, and the required number of sheets will vary accordingly. Below are two methods to consolidate private drives to a minimal number of sheets.

Reference profile drawings into one driveway profile drawing space.

1. After creating the drawing and sheet models using the name boundary tool for the first private drive shown on a Driveway Profiles sheet, a designer can take a driveway profile drawing space and reference in as many other driveway profile drawing models that will fit on one sheet.
2. The designer will need to label all profiles with the driveway type, side of the centerline, station, tract number, and alignment it is tied to within each profile's drawing model.
3. All individual **[sheet]** models created that have a drawing model referenced into the sheet used in **Step 1** can be deleted. For example, if driveways 1, 2 and 3 fit on one sheet together, then the sheet models for driveways 2 and 3 (not the drawing model that is being referenced) can be deleted from the model space.
4. Designers should add the sheet models to the sheet index and assign the correct starting sheet number.

Place multiple profiles in one sheet model.

1. After creating the name boundary for the first private drive shown on a Driveway Profiles sheet, the designer can select the same Sheet Name within the **Create Drawing** dialog box for any additional drives being shown on the same sheet as the previous profile. This will add the drive to the same sheet model.
2. The designer will need to manually move the driveway profile references to where they would like it placed on the sheet.
3. The designer will need to label all profiles with the driveway type, side of the centerline, station, tract number, and alignment it is tied to within each profile's drawing model.

3.9.8 Culvert Section(s)

The following are two options that a user can utilize to create a culvert section in ORD:

- **Option 1:** This is the easier option but only viable if the culvert has <u>no bends</u>. The user will utilize the **Civil Cross Section 2 Points** option and select the **Culvert XS 10H 5V** Drawing Seed. Once created, this will function like any other XS.

- **Option 2:** The user will draw a line that mimics the XS limits and then give that line a profile (normally existing ground). In the profile, the user will need to create a **3D Cut**, and then create a profile named boundary (and sheet) in the profile view with the **Culvert XS** seed. There are some limitations in doing this, as the 3D cut does not have line weights. Also, the profile is not able to annotate the 3D cut, and it slows down the profile view. However, this option is an acceptable workaround until the software is enhanced.

The linear elements required to build a culvert cross section along with the Drawing and Sheet models should be stored in the **SHT-Culvert Sections** file. Designers should work in the **Drawing** model for each culvert to annotate and populate the hydraulic data cell. Designers should attempt to consolidate the number of total culvert section sheets. To place more than one culvert section on a single sheet, designers should follow the methodology for placing multiple profiles on a single sheet outlined in Section 3.9.7. After creating all the necessary sheets, designers should then add the **Sheet** models to the **Sheet Index** and assign the correct starting sheet number.

3.9.9 Sign Schedule and Sign Structures

When creating sign schedule sheets, designers should use the **Sign Schedule Sheet** seed and name the file **SHT-Sign Schedule**. This file will contain all sign schedule sheets for a given project. Dashed lines have been placed on the **DES - SCRATCH - User 1** level to aid designers in placing signs and text uniformly. This level has been setup to not print when using TDOT's print styles. Signs should be added to the legend using the **Place Cell** tool and accessing the **TDOT SIGNS - Proposed** cell library. The signs are set to place at a **1:1** scale in the design model and would need to be scaled to show at 50 scale; however, the sheet model is at a 1:1 scale (inches). For most roadway signs, an x and y scale of **0.05** should correctly size the cell to be placed in the sheet model. If designers are trying to place a larger sign, it may be necessary to reduce the scale so that it fits correctly on the sheet. To start, there are six (6) sign schedule sheets within the seed, which should be enough for most projects. If more sheets are needed, designers should copy one of the sheet models and rename it. After creating all the necessary sheets, designers should add the sheet models to the sheet index and assign the correct starting sheet number.

When creating sign structures sheets, designers should use the **Sign Structures Sheet** seed and name the file **SHT-Sign Structures**. This file will contain all sign structures sheets for a given project. To start, there are six (6) sign structure sheets within the seed, which should be enough for most projects. If more sheets are needed, designers should copy the representative sheet boundaries in the design model and then copy a sheet model, adjust the reference location, and repeat to create as many sheets as needed. After creating all the necessary sheets, designers should add the sheet models to the sheet index and assign the correct starting sheet number.

3.9.10 Cross Sections

Each individual roadway will have its own cross section sheet file. This is necessary for earthwork annotation to be correct. To begin the cross section sheet creation, designers need to a create a file named **SHT-XS-Roadway** using the **TDOTSeed2D**. At a minimum, this file should have the following files referenced in:

- **SUR-Alignment** (*existing ROW*)
- **SUR-Terrain** (*set to active to create the 3D view, which is required to make cross sections*)
- **DES-Alignment**
  - It might be necessary to attach multiple **DES-Alignment** files to show in XS. It is not recommended to attach the **DES-Alignments-Master** file in the XS.
- **DES-Corridor-Road Name** (*do not use the corridor master file*)
- **DES-Earthwork-Road Name** (*earthwork for EAV table*)
- **DES-ROW**

If a roadway is made up of multiple corridors (e.g., when there is a bridge), it is necessary to also reference those files.

> *Take Note!*
>
> *If the specific design file does not show up on that specific roadway's cross section sheet, you do not want it referenced into the Design model (e.g., you do not want side road corridors referenced into the mainline Design model). Since mainline corridors are clipped at side roads, cross sections cut at a side road intersection station will require the user to manually create a matchline directing the reader to the proper XS location.*

After bringing in all the references, designers need to place cross section named boundaries in the design model. Refer to Lecture 8.6 in the Roadway Design I (ORD) Manual for the process. Before accepting the named boundary, designers can select **Create Drawing** before exiting the named boundary toolbox, if desired, to create the drawing and sheet models in one click. Once the drawing and sheet models are created, the cross sections will automatically be annotated.

> *If a cross section is cutting a surface terrain with an associated surface template, the software is not capable of annotating cross slopes automatically. This will occur most often when civil cells are placed in a model and anywhere designers choose to model without linear templates. On most projects, this will result in only a few cross sections that will require some level of manual cross slope annotation.*

Take Note!

Pre-10.11 (*ORD Version*)

The following steps should be used to manually determine cross slopes:

1. Open the **Line Between Points** tool and draw a line that represents the cross section cut line (essentially a pattern line in GEOPAK).
2. Open the profile model of the line that was drawn.
3. Use the **Profile Intersection Point** tool to pull the intersection of all lines / breaklines that cross this element into the profile view.
4. Use the **Profile Line Between Points** tool to draw lines between the intersecting points. These lines will tell designers what the cross slope is between lines / breaklines.
5. Repeat the previous steps for all cross sections that require manual cross slope annotation.
6. Open the cross section drawing models and annotate the cross slopes using the information gathered in Step 5. It is recommended to copy an automatically annotated label, rename, and move it to the desired location to ensure consistent annotation.

10.11 and Later (*ORD Version*)

The **civil labeler** has two labels for annotating cross slopes. In order for the label to work, two linear elements within the **3D** model will need to be selected. Terrains, surface templates, and MicroStation lines in the **Drawing** model cannot be annotated this way.

If the project phase requires earthwork to be displayed on the cross sections, designers will need to follow the following steps in the cross section **sheet** file where the annotation is to be placed:

1. Reference in the applicable **DES-Earthwork-Road Name** file (not the DES-Earthwork-Master file).
2. Run the **End Area Volumes Report** tool for the cross section named boundary.
3. Open the drawing model space of the first cross section sheet.
4. Open the **Annotate Model** tool and select the **XS EAV Table** annotation group and apply to all drawing models.

The earthwork cut and fill volumes should now be placed on the cross section sheets and populated with the end area volume calculations created in the end area volumes report. After creating all the necessary sheets, designers should add the sheet models to the sheet index and assign the correct starting sheet number.

Take Note!

In pre-10.11 ORD versions, if any surface templates are within the cross section, the EAV table will not place, which is a software defect. As a temporary fix, the designer should copy an EAV table that placed correctly and then update the values based on the EAV Report.

Chapter 4. Plans Production and Deliverables

4.1 Sheets in OpenRoads Designer

The sheet development process in ORD is different compared to the previous process in MicroStation. Section 3.9 discussed how to create different sheets. This section will discuss how sheets are utilized within the plan production process.

All sheets are true size and by default are set to be **34"x22"**. This means that any **Drawing** model reference will need to be scaled down to fit on the sheet. For example, for plan views with a **1"=50'** annotation scale, the reference will need to be **1:600**, which represents the true size of both the Design and Drawing models. If a user manually moves a Drawing model to a different sheet for a driveway profile, culvert section, etc, it will not be able to fit on a sheet unless scaled down with the proper ratio.

If a user wants to print **11"x17"** sheets, it is not recommended to change the sheet size but rather scale down the PDF after creation. This will keep the printed line weights scaled proportionately to the sheet.

There are several elements in the plan and profile sheet seeds that only exist for the software to use during the sheet creation process. These elements are intended to be turned off and are on the following levels. If left on, they are set to not print.

- DES - SCRATCH - User 1
- DES - SCRATCH - User 2
- DES - SHEET - Plot Shape (*defines the outside plot area of the sheet*)

The sheets should automatically have **Constructions** turned off for all elements in the **Drawing** model. If a user needs to print an element on a construction level, it is recommended to change it to the **Primary** class.

The sheets are set up with automatic annotation in both the top and bottom right corners:

- **Top Right Corner:** The **TYPE**, **YEAR**, and **PROJECT NO.** are **Sheet Index** properties and must be filled in for the automation to work. These fields will only populate within the sheet once the **Sheet** model has been added into the Sheet Index. For the **SHEET NO.**, only the first row is filled out automatically. If a user needs the sheet number populated in the next two rows, copy, and paste the sheet number from the first row and unlink the text from the sheet number. This can be done by either going in and editing the text, or by dropping the text to a shape. The sheet number is linked to a property that is contained in the **Model** properties. If a sheet is removed from the Sheet Index, it is possible that the link can break and would need to be relinked.

- **Bottom Right Corner:** For plan and profile sheets, the station range will automatically populate and align with the matchline stationing, along with the applicable sheet scale. For cross section sheets, the station range will automatically populate along with applicable sheet scales. The user will still need to manually key in the sheet title for plan sheets and some profile sheets.

Take Note! | *Currently, there is a software defect for TDOT's sheet seeds. When creating sheets, the **Level Display** can be inconsistent between two sheets in a named boundary run. It is recommended to quickly review every sheet and make sure the level visualization is correct.*

4.2 Create a PDF

To create a PDF, designers can access the sheet index from any dgn file associated with a given workset. Designers can select the **Plan Set** folder if the goal is to print the whole set at once. If designers want to print a specific folder (e.g., Present Layout), then select only that folder. If a single sheet is desired, then select only that sheet. After selecting the sheet(s) or folder(s) that are to be printed, select **Open Print Organizer** within the sheet index, which will then prompt a print style to be selected. TDOT has three (3) available print styles:

- TDOT PDF (Full Black and White)
- TDOT PDF COLOR (Full Color)
- TDOT PDF PERMIT (8.5" x 11" Black and White)

Within the print styles, various levels are currently set to not print. For example, the following levels within the **TDOT PDF** print style fall in this category:

- DES - CORRIDOR GRAPHICS - Conceptual
- DES - CORRIDOR GRAPHICS - Controls
- DES - CORRIDOR GRAPHICS - Design
- DES - CORRIDOR GRAPHICS - Final
- DES - CORRIDOR GRAPHICS - Superelevation
- DES - CORRIDOR GRAPHICS - Superelevation Left Lane
- DES - CORRIDOR GRAPHICS - Superelevation Right Lane
- DES - SCRATCH - User 1
- DES - SCRATCH - User 2
- DES - SHEET - Plot Shape
- DES - XS - Earthwork - Shapes
- STR - SHEET - Plot Shape

*It is recommended for the designer not to use the **Default** level when placing design elements or anything intended to be printed. While this level should be turned off, it is still available to print.*

Take Note!

Selecting a print style will open the print organizer. From there, designers can continue to be selective of what is printed based on their selections. Clicking the **Print** icon will open the Print menu. From there the plot configuration can be changed, if desired, and other print functions can be adjusted. It is recommended under the **Submit** section to set the **Submit as** option to **Separate print jobs**. Then, click **Output File Names…** and select **<sheet number>** as the **Expression name**. Then, click **Preview Names** to review the PDF names and then close the preview window and click OK. By default, the print job outputs to the **out** folder within the workset. If desired, change the destination file path to save the file elsewhere. Lastly, click OK to run the print job.

After the print job is completed, designers should check and make sure all files were printed, and then combine the separate PDFs into a single PDF using a PDF editor.

ORD automatically combines a PDF comprised of multiple prints based on the folder organization of the sheet index and ignores the alphanumeric order (e.g., all present layout sheets would be grouped together). Therefore, it is recommended to use separate print jobs so that the order of sheets can be controlled before the overall PDF is created.

Take Note!

4.3 Design Stage Progression and Revisions

As a project progresses through the submittal phases, it is likely that sheets will be added or renumbered. When this happens, designers should copy the sheet number from the previous phase and place it in the sheet number block below it. This will carry the intelligent text linked to the sheet index for the sheet number down to where the new number will be displayed. In the sheet number block from the previous phase, designers should edit the text, copy the text, and re-paste it to remove the data link.

If sheet revisions are necessary, designers should open the applicable sheet model and turn on the **DES - SHEET - Revision Text** level and input the required information to document the revision.

4.4 Standard Plan Submittals for ORD Projects

The following section is intended to provide guidance on major file submittal packages in alignment with the TDOT PDN stages for projects produced in ORD. Each subsection below specifically highlights files that are <u>always required</u> as part of the corresponding submittal package for final submittals in each of the PDN Stages 1-4. Additional deliverables for various disciplines (i.e., Bridge, ITS, Lighting, NSD, Retaining Wall/Noise Wall, Signal, Geotechnical, Hydraulic, Utility, SWPPP, etc.) will need to be included in the submittal package, if applicable, and are listed for each PDN stage submittal in RDG-PDN Chapter 1. Additionally, email templates for submittals have been created to replace submittal memo letters, and they are to be utilized to complete the submittal process at each PDN stage. These templates can be found under **Design Standards >> Roadway Design Documents - PDN >> Submittal Templates**. **RDG-PDN Chapter 1** and shall be used as the primary reference for all project files being submitted at **any PDN stage**. These submittal package files reference the project PIN number, as opposed to the project number for <u>survey</u> and <u>design</u> files. In the following sections, **nnnnnn-nn** is intended to represent a project's **PIN** number.

> *Prior to a submittal, work from all other divisions will be sent to roadway design and incorporated into their roadway workset. Once completed, this will serve as a project's Master Workset for submittal.*
>
> **Take Note!**

4.4.1 Line and Grade Package Field Review Submittal

When submitting Line and Grade Package Field Review Plans, all comments received from Project Team discussions or Quality Assurance/Quality Control (QA/QC) review need to be addressed. Plans should follow all applicable specifications listed in the Line and Grade Plans Checklist. Aligning with Section 4.5, the Line and Grade Package Field Review Master Workset Zip File (***nnnnnn-nn-LineandGradePlans.zip***) should be submitted, along with the following files, as part of the **Line and Grade Package Field Review** submittal listed in RDG-PDN Chapter 1:

- Line and Grade Package Field Review Roadway Plans
  - *Naming Convention*: **nnnnnn-nn-LineandGradePlans.pdf**
- Line and Grade Package Field Review Estimated Roadway Quantities plan sheets (labeled **Info Only**)
  - *Naming Convention*: **nnnnnn-nn-RoadwayEstimatedQuantities.pdf**
- Signed Line and Grade Plans Checklist
  - *Naming Convention*: **nnnnnn-nn-LineandGradePlansChecklist.pdf**
- Line and Grade Package Field Review Plans Project Notebook
  - *Naming Convention*: **nnnnnn-nn-LineandGradePlans-PN.docx**
    (Refer to Section 5.3.1 for more information.)

4.4.2 Functional Design Plans Submittal

When submitting Functional Design Plans, all comments received from the Functional Design Review, SWPPP Consultant, site visits, or QA/QC need to be addressed. All sheets submitted should follow all applicable specifications listed in the Functional Design Plans Checklist. Aligning with Section 4.5, the Functional Design Plans Master Workset Zip File (***nnnnnn-nn-FunctionalDesignPlans.zip***) should be submitted, along with the following files, as part of the **Functional Design Plans** submittal listed in RDG-PDN Chapter 1:

- Functional Design Roadway Plans
  - *Naming Convention*: ***nnnnnn-nn- FunctionalDesignPlans-Roadway.pdf***
- Functional Design Estimated Roadway Quantities plan sheets (labeled **Info Only**)
  - *Naming Convention*: ***nnnnnn-nn-FunctionalDesignPlans-Estimate.pdf***
- Functional Design Traffic Control Strategies and Concepts (labeled **Info Only**)
  - *Naming Convention*: ***nnnnnn-nn-ConceptualTrafficControl.pdf***
- Original sealed Title Sheet
  - *Naming Convention*: ***nnnnnn-nn- FunctionalTitleSheet.pdf***
- Signed Functional Design Plans Checklist
  - *Naming Convention*: ***nnnnnn-nn-FunctionalDesignPlansChecklist.pdf***
- Functional Design Plans Project Notebook
  - *Naming Convention*: ***nnnnnn-nn-FunctionalDesignPlans-PN.docx***
    (Refer to Section 5.3.1 for more information.)

4.4.3 Plan-in-Hand Plans Submittal

When submitting Plan-in-Hand Plans, all comments received from the Plan-in-Hand Field Review, SWPPP Consultant, site visits, or QA/QC need to be addressed. All sheets submitted should follow all applicable specifications listed in the Plan-in-Hand Checklist. Aligning with Section 4.5, the Plan-in-Hand Plans Master Workset Zip File (***nnnnnn-nn-Plan-in-HandPlans.zip***) shall be submitted, along with the following files, as part of the **Plan-in-Hand Plans** submittal listed in RDG-PDN Chapter 1:

- Plan-in-Hand Roadway Plans
  - *Naming Convention*: ***nnnnnn-nn-PIH-Roadway.pdf***
- Signed Plan-in-Hand Checklist
  - *Naming Convention*: ***nnnnnn-nn-PIH-Checklist.pdf***
- Plan-in-Hand Plans Project Notebook
  - *Naming Convention*: ***nnnnnn-nn-PIH-PN.docx***
    (Refer to Section 5.3.1 for more information)

4.4.4 Final PS&E Documents "Complete Package" Submittal

When submitting Final PS&E Documents or "Complete Package", all comments received from the PS&E Field Review, SWPPP Consultant, site visits, or QA/QC need to be addressed. All sheets submitted should follow all applicable specifications listed in the PS&E Checklist. Aligning with Section 4.5, the Final PS&E Package Master Workset Zip File (***nnnnnn-nn-FinalPS&EPackage.zip***) should be submitted, along with the following files, as part of the **Final PS&E Documents "Complete Package"** submittal listed in RDG-PDN Chapter 1:

- Original sealed Functional Design Title Sheet
    - *Naming Convention: **nnnnnn-nn-FunctionalDesignTitleSheet.pdf***
- Signed Traffic Management Plan
    - *Naming Convention: **nnnnnn-nnTMP.pdf***
- Complete sealed Final PS&E Roadway Plans
    - *Naming Convention: **nnnnnn-nn-PS&E-Roadway.pdf***
- Signed PS&E Checklist
    - *Naming Convention: **nnnnnn-nn-PS&E-Checklist.pdf***
- Final PS&E Plans Project Notebook
    - *Naming Convention: **nnnnnn-nn-PS&E-PN.docx***
      (Refer to Section 5.3.1 for more information)

4.5 Standard Zip File Submittal for ORD Projects
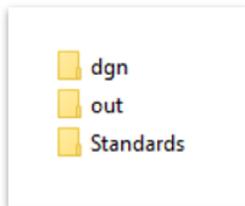
When submitting a project at its respective PDN stage per RDG-PDN Chapter 1, a project workset zip file will also be required along with the plans and other supplemental documents as defined in the preceding section. When a Workset is created for each project, three (3) folders will automatically be created: **dgn**, **out**, and **Standards**.

- **dgn folder:** Where all the DGN files are stored, along with quantities, plan note documents, and any other files that are included in the plan set creation. These files should follow the standard naming conventions.

- **out folder:** Where all individual PDF sheets from the current plan set are created and stored. This location can also be used to house any reports run within the ORD software. It is up to the TDOT Project Manager to decide what contents of this folder should be zipped and submitted as part of a project phase.

- **Standards folder:** Where any project specific standards are saved, such as the project specific template library. This folder also includes the **Project Notebook** (refer to Section 5.3.1), and any other project specific standards.

These three (3) folders make up the content of the workset and will fully document a project's progress and all design components. It is required to zip the entire Workset in one (1) file including the corresponding **dgnws** and **cfg** files. Within the zipped Workset, it is important that the **dgnws** and **cfg** files are located outside the project folder containing the **dgn**, **out**, and **Standards** folders. If not, the workset will not function properly. Essentially, the zipped Workset should retain the same folder structure as shown in Figure 1. Any changes to this recommendation shall be approved by the TDOT Project Manager.

4.6 Stamping a Set of Plans

There are several ways to place a stamp on a set of plans. If the designer wants to use their SS2 stamp, the designer will need to place the stamp as a cell and scale the stamp to the appropriate size. The stamp can also be placed as a watermark after printing and before the set is digitally signed.

Chapter 5. Requirements for Model-Based Design

TDOT understands the value of **Electronic Engineering Data** (EED) and will continue to examine the full digital delivery workflow. There are various expected benefits of EED including:

- Increased productivity
- Reduction in design errors
- Conformance to industry trends of AMG (Automated Machine Guidance), eConstruction and Asset Management

Furthermore, ORD CONNECT Edition products allow designers to produce a product that retains the civil data and design intent through construction. As noted earlier, project deliverables will continue to be in the form of a **sealed PDF plan set**, which represents the contractual legal document. The **3D model** will serve as **supplemental** data for now. The following sections provide general guidance and recommendations for TDOT related to full digital delivery methods and will be refined as best practices evolve. Standard naming conventions, data management, and exchanges for each phase of the project development process are necessary when working with digital design models, as outlined in previous sections. Thus, the information herein will focus on defining roles and responsibilities, data management, milestone reviews, and deliverables for specific authorized uses for construction applications.

5.1 General Requirements

A key success factor when delivering digital design models is being able to communicate the purpose and need for each deliverable, which will let the design team know what content and level of development is needed for the model. **Level of development (LOD)** is defined as a qualitative designation that communicates the degree of engineering intent behind a 3D model. LOD can also communicate the authorized uses for which a model should be used. Normally, the LOD will increase through the design development process. The concept of LOD can be broken down into two (2) categories:

- **Model Density:** Relates to how much detail is in the model.
- **Confidence Level:** Relates to how much uncertainty the model is based upon.

Figure 8 illustrates the relationship between model density and confidence level as these two (2) categories pertain to LOD and 3D data usage.

FIGURE 8. FIGURE RELATIONSHIP BETWEEN MODEL DENSITY, CONFIDENCE LEVEL, AND 3D DATA USE
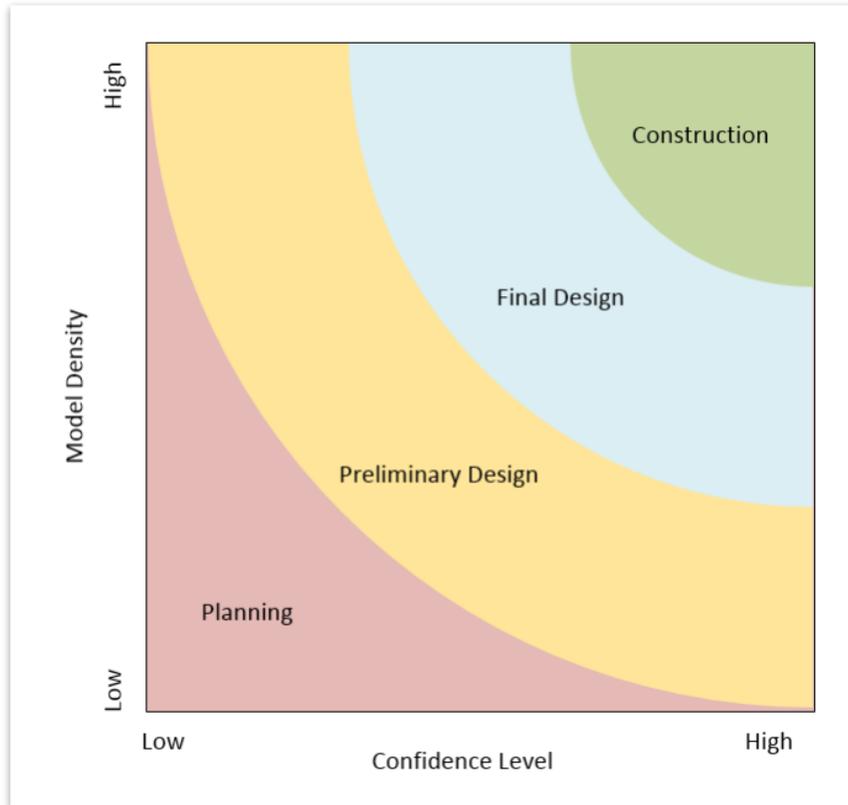
Furthermore, LOD is traditionally broken down into LOD types or tiers to appropriately identify the level of information and the level of graphical detail for each. LOD types communicate and define graphical and non-graphical details. Table 1 on the next few pages provides a summary of recommendations for 3D model deliverables based on purpose and need. As TDOT progresses in the model-centric design environment, this table will be used as a starting point to identify LOD types and associated criteria.

TABLE 1. RECOMMENDATIONS FOR 3D MODEL DELIVERABLES BASED ON PURPOSE AND NEED

Purpose and Need of 3D Model	LOD Requirement	Final Design Model Deliverable
Survey Layout (STAKING)	• 2D/3D line work representing centerline, right-of-way lines, and grade break lines modeled. 　○ 25-foot point interval in tangents. 　○ 10-foot point interval in curves. • 5-foot point interval in transitions.	• Alignments, profiles, 3D line strings, and survey control files.
Public Outreach Visualization (VIZ)	• Photorealistic. • Traditionally, basis of original ground survey is unknown, or there is a high probability that original ground survey does not reflect field conditions.10-foot point interval in curves.	• Still images and videos.
Risk Construction Management (RCM)	• Specified work breakdown structure (WBS) of activities. • Critical path method (CPM) schedule. • Geometric models with 3D solids depicting the elements needed for WBS activities. While the 3D model does not need to be of high survey accuracy, it can serve as the basis for the 4D model. Design team should discuss specific requirements with visualization team creating the 4D model.	• Corridor model(s) as needed for sequence of construction activities and stages. • 4D model showing sequence of construction work based on the work breakdown structure (WBS) and activities used for critical path method (CPM) progress schedules as still images and/or videos.
AMG – Grading (AMG-G)	• Geometrically and geospatially accurate 3D elements depicted in the roadway typical section, including existing ground, proposed pavement design, clear zone, and side slope conditions (e.g., traveled way, shoulders, and side slopes) • Model typical templates should be designed at regular stations: 　○ 25-foot point interval in tangents.	• Proposed terrain surface depicting either the proposed finished grade or subgrade (top of dirt) for the roadway traveled way and side slope conditions. • Civil geometry. • All line work showing all grade breaks.

Purpose and Need of 3D Model	LOD Requirement	Final Design Model Deliverable
	○ 10-foot point interval in curves. ○ 5-foot point interval in transitions. • Model key station templates should be designed at horizontal and vertical transitions such as lane widenings, gore areas, superelevation critical sections and intersections. • May include feature attributes such as pay items.	• Survey control file.

AMG – Paving (AMG-P)	• Geometrically and geospatially accurate 3D elements depicted in the roadway typical section, including existing ground, proposed pavement design, clear zone, and side slope conditions (e.g., traveled way, shoulders, and side slopes)
	• Model typical templates should be designed at regular stations:
	  ○ 10-foot point interval in tangents.
	  ○ 2-foot point interval in curves.
	  ○ 2-foot point interval in transitions.
	• Model key station templates should be designed at horizontal and vertical transitions such as lane widenings, gore areas, superelevation critical sections and intersections.
	• May include feature attributes such as pay items.
		• Survey control files.
		• Civil geometry.
		• All line work showing all grade breaks or/and surfaces showing structural pavement limits.

Constructability Reviews (CR)	• Geometrically and geospatially accurate 3D elements depicted in the roadway typical section, including existing ground, proposed pavement design, clear zone, and side slope conditions (e.g., traveled way, shoulders, and side slopes) • Model typical templates should be designed at regular stations: ○ 25-foot point interval in tangents.	• Existing topography (3D solids representing existing features from lidar if available). • Civil geometry model(s). • Corridor model(s). • Drainage model(s). • Utility model(s). • Structure model(s) (if available).

Purpose and Need of 3D Model	LOD Requirement	Final Design Model Deliverable
	o 10-foot point interval in curves. o 5-foot point interval in transitions. • Model key station templates should be designed at horizontal and vertical transitions such as lane widenings, gore areas, superelevation critical sections and intersections. • May include feature attributes such as pay items.	
Quantity Take-offs	• Alignments, surfaces, and 2D/3D line work. • ORD model.	• Alignments, surfaces, and 2D/3D line work. • ORD model.

5.1.1 Roles and Responsibilities

It is recommended to define roles and responsibilities for the project team during the scoping phase, at which time the project delivery team should start defining the model development requirements.

The three key stakeholders in a model-centric project delivery process are the parties who **create** (author), **use**, and **manage** the model. The model author(s) is responsible for developing one or many elements of a 3D model (e.g., geometry, corridors, drainage, utilities). The model user is any party consuming information derived from the model directly or indirectly (construction, geotech, contractor, etc.). Lastly, the responsible party to manage the model is that single point of contact for all inter-disciplinary and model-related issues. This person is typically known as a **Digital Delivery** coordinator or **Building Information Modeling (BIM)** coordinator, and they are responsible for managing the collaboration and quality control processes, as well as other duties to ensure successful use of 3D models during project delivery.

Furthermore, a Digital Delivery or BIM Coordinator is the keeper of all documentation and may serve as the quality control (QC) manager during the design phase, but also post-award this person keeps track of all digital design model information.

- Work with the project delivery team to facilitate multi-disciplinary collaboration (constructability and environmental reviews, etc.).
- Communicate the purpose and need for the models (automated machine grading, visualization, etc.).
- Document the responsibilities of stakeholders (who creates and review content).
- Select the tools to be used for collaboration and data management.
- Describe the model development specifications (survey, design and utility accuracies and digital as-built requirements).
- Identify strategies for managing risk, responding to changes, and resolving any issues or discrepancies.

5.2 Model Development Specifications

5.2.1 Level of Development and Accuracy Specifications

The **Level of Development (LOD)** and **Level of Accuracy (LOA)** specifications define the reliability of the information contained in the model in terms of design intent and certify survey accuracies for existing conditions. LOD specifications are used to communicate allowable authorized uses, whereas LOA specifications are used to manage risk during construction. TDOT may define LOD specifications for the following authorized uses:

- **Existing terrain condition survey models (aerial and ground):** Holistically, the survey deliverables will contain all features currently collected by aerial and ground surveys, the terrain model, preliminary alignment, and 3D utility model. It is also important to discuss minimum survey accuracies that will support the intended use.

- **Automated machine guidance (AMG) construction models:** These models should contain sufficient information for contractors to use with their AMG equipment for grading and paving. TDOT will be engaging with the contracting community to understand what information and types of files are preferred.

  In general, AMG grading equipment requires a digital terrain model (triangulated network) that represents the surface to be graded. It is typical to deliver a terrain surface that represents the Design **Proposed Finished Grade**. However, contractors may request one of the <u>additional</u> three (3) surfaces shown below, which have been setup in the TDOT workspace as graphical filters. AMG models for paving typically require alignments, profiles, and 3D breaklines representing the edge of structural pavement.

  <u>Design</u> **Proposed Finished Grade (PFG):** *Final elevation of ground surface after all alteration, including grading, grubbing, filling, excavating, paving.*
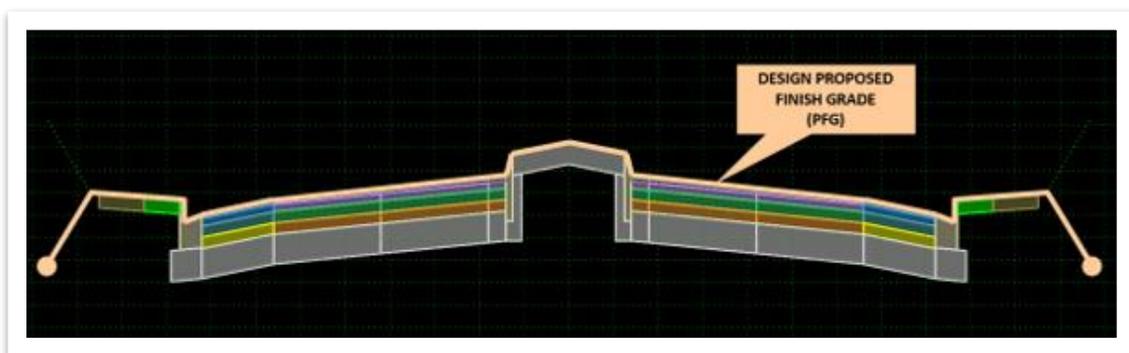
Design **Grading Surface (GS):** Area along existing ground that will be affected by the proposed finished grade.
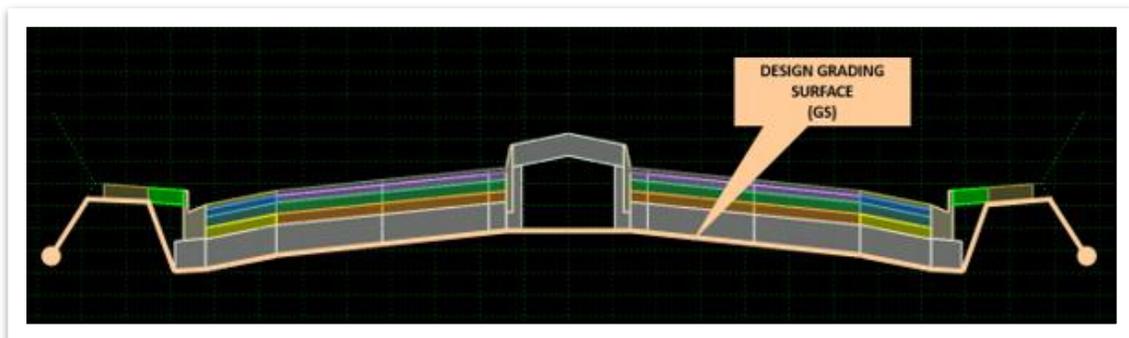
Design **Paving Surface (PS):** Proposed traveled way area.
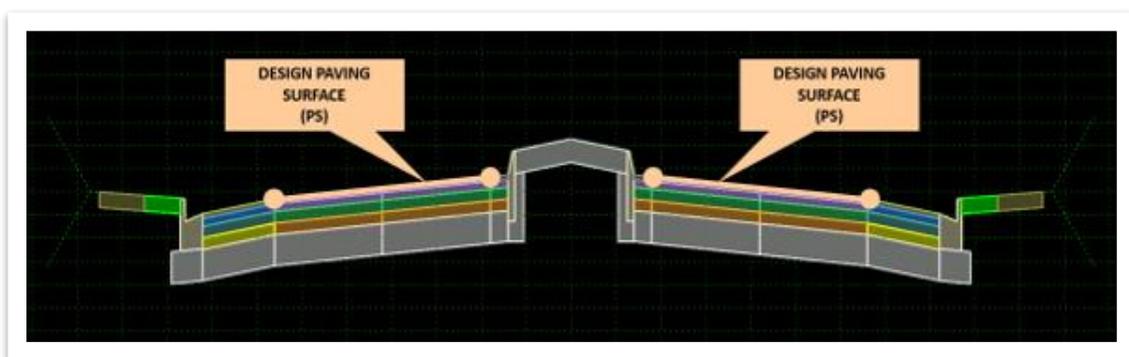
Design **Roadway Surface (RS):** Proposed approach roadway area.
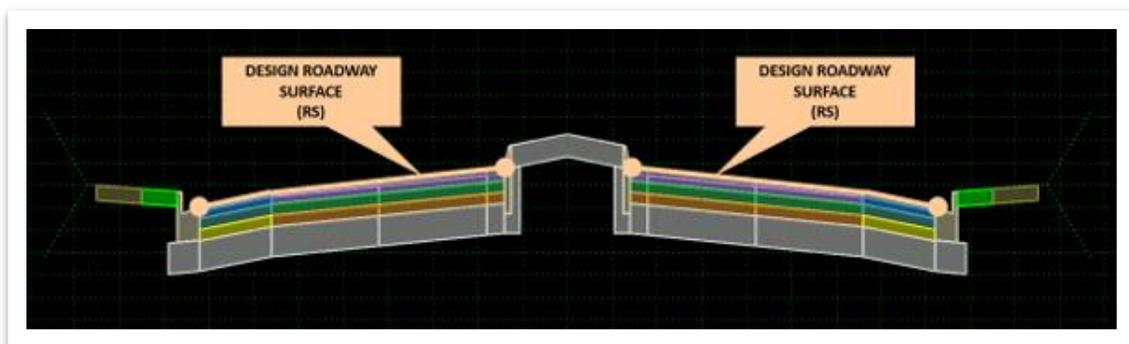
- **Roadway models for plan production:** Models intended for plan production should contain sufficient information for designers to develop plan, profile and cross section sheets as required for a contract plan set. Examples of elements included in the roadway model are alignments, profiles, and corridor geometry (e.g., superelevation, pavement and shoulder design, fill/cut slopes, ditches). These models may also include certain visualization elements, such as 3D guardrail and traffic control devices (e.g., barrels and cones).

- **Closed-drainage system models:** Drainage models are intended to help engineers design and analyze hydraulic properties of the drainage network. In addition to the calculations required for hydraulic design and analysis, ORD creates a physical model of the drainage network. This model can be referenced to the roadway model to present a complete picture of the roadway project.

- **Utility models:** These models include existing and proposed utilities modeled as 3D shapes. Existing and Proposed utilities should be modeled utilizing the SUDA tools. Bentley is continuing to enhance the SUDA tools that will make modeling **existing** utilities more efficient in the future.

- **Roadway models for multi-disciplinary collaboration:** Models intended for multi-disciplinary collaboration are a collection of different models developed by different disciplines. Typically, these models include roadway, drainage, utilities, and structure models.

5.2.2 Level of Visualization (LOV) Guidelines

It is important to specify what level of visualization is expected for different applications. The more photo-realistic and content added to the visualization, the higher the cost. The software used for 3D design has many standard tools available to the designer to do basic visualization, such as visual textures based on 3D template components and showing striping. However, to create visualization outputs, the software requires an additional level of effort to set lighting, placing cameras in the view, and rendering images. This sophisticated level of visualization is usually reserved for public outreach and communication of high-profile projects.

5.3 Project Data and Documentation During Design

5.3.1 Project Notebook

Any projects surveyed in ORD, converted to ORD, and all new projects started on **1/12/2024** or later are required to submit the **Project Notebook** at each project submittal. The Project Notebook Template can be found on the TDOT CADD Support website under **ORD Resources >> Requirements and Guidelines**. It should be stored in the **Standards** subfolder of the project workset and is intended to record the life cycle of the project from context/scoping at Stage 1 through PS&E at Stage 4 of TDOT's PDN. The Project Notebook is a living document that records the design criteria followed, design parameters used, key decisions, ORD versioning and modeling information, alterations from any standard design procedures and/or workspace configurations, and any other important design related impacts.

> *The Project Notebook is expected to grow with each design stage to document additional details and decisions made. It is not expected to be fully completed in the earlier stages of the design process; however, it is important to begin populating this document from the start.*
>
> **Take Note!**

The Project Notebook will most likely be filled out by the **Roadway Team**. Any information to be included from other functional areas should be communicated to the Roadway Team and incorporated into the overall project design and notebook. It is also intended to be referenced by all members of the project team to ensure all information presented is accurate and reflected in the submittal packages. It will be utilized for review of design accuracy, 3D model sufficiency, and serve as a project's official documentation throughout the continuance of a project.

The Project Notebook has been broken into the following chapters:

- **Chapter 1:** Contains the basic project information and background, including identifying information, project narrative, survey information, and submittal log and information. It is important to keep a record in this chapter of the ORD release and TDOT workspace at the time of the submittal along with any design updates, ORD customization, and design issues with their respective solutions.

- **Chapter 2:** Contains roadway specific information, including design criteria, design information, and modeling information for <u>each</u> **roadway** within the project limits. The Project Notebook will only be populated with Chapter 2 initially, including all information that may need to be documented for an individual roadway. It is recommended to copy and paste all of Chapter 2 for all mainlines and side roads present, before filling out any project specific information. Once each roadway has its own chapter, designers can begin the process of populating the different sections. There may be some sections of the Project Notebook that do not apply to each project (e.g., sidewalks, retaining wall, etc.). It is recommended to collapse these sections rather than delete them to shorten the overall document length.

> *It is not necessary to have an individual chapter for **Private Drives** or **Haul Roads**, since these alignments can be documented within the roadway alignment that they intersect (e.g., haul road information can be recorded within the **Traffic Design** subsection.)*
>
> **Take Note!**

The **Roadway** chapter is broken into the following three subsections:

1. **Design Criteria:** Documents the referenced design standards (i.e., TDOT Standard Drawings, TDOT Guidelines and Standards, and other standards publications). This information should be utilized by the project team to fully understand the design criteria, which will also allow for more efficient quality control checks. The following are examples of documented information in this section:

- Minimum Horizontal Curve Radius
- Maximum Superelevation Rate
- Minimum Degree of Vertical Curvature (*Sag and Crest*)
- Maximum Grade

2. **Design Information:** Documents the parameters used within the project model. Designers should reference the **ORD Explorer** and the different **ORD Reports** that are provided in the workspace to efficiently fill in the parameters. This information should be used by the project team to fully understand the design specifics, which will allow for assurance that the design criteria has been applied correctly. The following are examples of documented information in this section:

   - Curve Radius Used and Superelevation Rate
   - Minimum and Maximum Degree of Vertical Curvatures Used (*Sag and Crest*)
   - Geotechnical Recommendations
   - EPSC Design Description

3. **Modeling Information:** Documents how a roadway is modeled and controlled in ORD. This information is important if there are multiple designers on a project from a consistency standpoint, as well as if there are any personnel changes before a project's completion. This section is also used to assist the design model reviewers in understanding how controls were applied and utilized. The following are examples of documented information in this section:

   - Major Model Revisions Log
   - Project Customization
   - Corridor Template Drops
   - Corridor Controls

   Note: There may be additional modeling information that could be beneficial to record that doesn't fall under any of the default sections. In this case, the Roadway Team can add the necessary sections based on specific project needs (maintaining the overall format of the Project Notebook).

The **Project Notebook** will be submitted at each stage of the PDN process along with all other required deliverables listed in RDG-PDN Chapter 1. It is recommended that the Project Notebook be submitted in **PDF** format for all submittal stages.

5.3.2 3D Model Checklist

ORD is a model-based design software. The plan sheets created as part of each submittal are a **2D** view of the **3D** design model. As stated in Section 1.1, the sealed PDF plan set is still the contractual legal document. For now, the 3D Model is supplemental until TDOT transitions to full digital delivery. However, it is still important for the 3D Model to be an accurate, detailed representation of what a proposed design should look like once constructed. To ensure this accuracy and level of detail is reflected in all TDOT projects, a **3D Model Checklist** has been created and is required to be filled out and submitted with each deliverable. It can be found on the TDOT CADD Support website under **ORD Resources >> Requirements and Guidelines**.

The 3D Model Checklist is organized by individual design components that should be verified. Each category will have multiple checks within it to ensure that all components are accounted for. For example, the **Superelevation** (SE) category is broken into **four** components:

- **Rates and Transitions:** Check that these values meet the design criteria and are input correctly into the model.
- **Rates and Model:** Check that the SE is applied correctly to the active corridor.
- **Diagrams:** Check that the SE diagrams are displayed correctly.
- **Rollover Transitions:** Check that these transitions meet the design criteria and have been applied correctly.

If the model reviewer can verify that all four of these components have been incorporated for each roadway present, then the accuracy and detail of this design component meets the expectations necessary for the submittal.

Take Note!

__The 3D Model Checklist references the information recorded in the Project Notebook__. It is not the responsibility of the model reviewer to check that the information shown in the 3D Model follows design standards, only that it matches the values shown in the Project Notebook. It is the responsibility of the design team to ensure the design shown in the 3D Model and recorded in the Project Notebook are following all TDOT Standards.

5.3.3 Model Inventory Spreadsheet

A Model Inventory spreadsheet is being developed with TDOT to help design staff document project data. The Model Inventory will list the project manager, authors, model reviewers, and other related project information. The Model Inventory will also be used as the quality assurance to document the quality control performed on the design files at each of the PDN stages. TDOT will use the Model Inventory to keep track of model elements and their certified LOD and LOV. The Model Inventory will be stored in a centralized location, such as the project's FileNet folder or SharePoint location so authorized users have the ability to edit information in the file. Specifics of the Model Inventory will generally include the following:

- Information about elements modeled.
- LOD and LOV specifications for each modeled element.
- Authorized uses.
- Name of responsible party for developing the model.
- Certified survey quality and project combined scale factor.
- Any additional comments or notes.

More information on the Model Inventory standard processes will be released once the documentation guidance is completed and fully adopted by TDOT.

5.3.4 ORD File Deliverable Handoff Documents (coming soon)

A focus of the PDN process is providing consistency and transparency throughout a project's delivery process. A key aspect of this workflow is the collaboration between multiple functional areas that will work together on a project, which will result in project file(s) being exchanged via the project team. Six **ORD File Deliverable Handoff Documents** have been created to assist with this workflow between **roadway design** and the following functional areas:

- Environmental
- Geotechnical
- Right-of-Way
- Structures
- Traffic Operations
- Utilities

They can be found on the TDOT CADD Support website under **ORD Resources >> Requirements and Guidelines**. These documents utilize the overall master ORD project workset, which will be provided to the functional areas by roadway design during plan development so they can review the latest files and create their applicable CADD files.

The handoff documents include tables that list the files that will be utilized between the functional areas. The first table in each document shows the files within the ORD project workset that will be most beneficial for the respective functional area to reference or review. For example, the **PRJ NAME-DES-Alignments-Master** file created by roadway design will likely be beneficial for the majority to reference or review as they complete their own design work. The second table in each document shows the files that will be created by each functional area and then provided back to roadway design to add to the ORD project workset. These files usually include discipline specific sheets or a reference file that roadway design should incorporate into the main plan/profile/cross section sheets.

All files that are listed within the handoff documents can also be found in the TDOT ORD File Naming Convention Standards document.

> *Within the appendix of the **Environmental** handoff document, the possible collaboration between Environmental and Structures is further described.*
>
> **Take Note!**

5.3.5 Milestone Reviews

Milestone reviews should be conducted and include applicable project stakeholders throughout the lifecycle of the project. These collaborative reviews allow the project team to find issues in a virtual environment early in the process to avoid costly changes late in the process or during construction. **Navigator** is Bentley's platform for model review and collaboration.

5.3.6 Model Changes During Construction

It is important that a protocol for documenting changes and managing versions of the files be defined. The **Digital Delivery** coordinator should follow the project throughout construction to assist operations with adjusting the model without compromising the construction schedule. If a Digital Delivery coordinator is not available during construction, it is important to define which changes constitute the necessity to go back to the **Design** team for revisions.

Deliverables submitted through FileNet should have a folder structure for the most current models, including a corresponding list of changes from version to version. A **historical** folder is often used to keep a complete model history of the changes pertaining to the project. Furthermore, a model inventory for post-award changes should be kept up to date with changes, including the reason for the changes, when the changes occurred, who updated and certified the model, and for what the model was used. This is important for resolving any discrepancies between layout, placement, and inspection.

5.4 Contract Requirements for 3D Models

It is recommended that TDOT use legal contract language for both consultants and contractors when indicating the design and use of 3D models on projects, including alternative delivery. The sample text below will eventually be reviewed by TDOT's Legal Division but is intended to serve as a guide for developing specific text for each entity.

5.4.1 Consultant Requirements

TDOT plans to use 3D engineered models for design, authoring, and development of contract plans and for contractor use of Automated Machine Guidance (AMG) for grading and paving, and construction inspection and verification. Contract Plans for Highway Construction should continue to be produced electronically in accordance with TDOT requirements. The consultant should work closely with TDOT to develop a **Project Execution Plan** (PxP) that:

- Defines authorized uses of specific engineering data.
- Roles and responsibilities for different tasks.
- Specifications for survey accuracies to meet model development requirements and authorized uses.
- Protocols for data management, validation, and information exchanges.
- Requirements for collaboration tools; and strategies for managing risks.

5.4.2 Contractor Requirements

TDOT plans to use 3D engineered models for design, authoring, and development of contract plans for contractor use of Automated Machine Guidance (AMG) for grading and paving, and construction inspection and verification. TDOT shall authorize the engineering digital data files distributed with the contract plans.

The contractor shall comply with TDOT's Standard Specifications for Road and Bridge Construction (Section 105.04), and the Contract bid book. These documents should be utilized to resolve any discrepancies between the engineering digital data and the contract plans.

Upon contract award, the contractor shall participate in a pre-construction meeting with TDOT staff and consultants to develop a **Project Execution Plan** (PxP) to define roles and responsibilities, as well as protocols for validating and documenting any field changes to the models and manage data files.

Revision History

DATE (MONTH/YEAR)	AUTHOR/EDITOR	SECTIONS MODIFIED
June/2022	WSP USA	Reorganization of sections for clarity and to align with the design process. Updates made to reflect the 10.10.21.04_04.21.22 TDOT ORD workspace.
February/2024	WSP USA	New / holistically updated sections: 2.2.1, 2.2.3, 3.7.2, 3.7.9, 3.7.10, 4.1, 4.4.1, 4.4.2, 4.4.3, 4.4.4, 5.3.1, 5.3.2, 5.3.4, Appendix A.2, and Appendix B. Section additions / updates based on the alignment with the PDN workflow, the latest project deliverables, Bentley and design process guidance, file management information, troubleshooting resolutions. Additional updates made to reflect the **10.12.02.04_12.21.23** TDOT ORD workspace. Converted the majority of the Notes into the blue "Take Note" format.

Appendix A. Conversion Guidance

Appendix A.1 Conversion of Existing Projects (GEOPAK) to ORD CONNECT

Now that ORD CONNECT has been deployed statewide, all new projects should begin with survey data prepared per ORD workflows, as outlined within the Survey (ORD) Manual. Existing projects (PPRM system) will be analyzed on a project-by-project basis to determine if a project should be converted to ORD. In-house designers and external consultants should coordinate with their applicable TDOT design manager to determine if a project should be converted or not.

To guide design managers and decision-makers, conversion graphics have been developed. In general, if a project is in the preliminary design phase, there may be added value to convert it from SS2 to ORD. Conversely if a project has been funded for construction, it is best suited to progress forward as-is in SS2. Design managers and applicable staff should reference the graphic located in Appendix A.3 if a project is within the **Right-of-Way (ROW) phase**. This area of project design development tends to have more variables and elements to consider with regards to conversion.

In addition to the conversion guidance figures outlined in Appendix A.2 and Appendix A.3, designers/design managers should consider the following criteria during the conversion evaluation process:

- How much effort has been put into developing plan sheets and cross sections?
- How often are designers making changes to the design and revising plan sheets?
- How often are designers updating cross sections?
- What is the timeline of the project?

Design managers should reference and complete the **ORD Conversion Decision-Making Form** which accompanies the above referenced conversion graphic(s).

The following two (2) conversion graphics (**ORD Conversion Decision-Making Flow Chart** and **ROW ORD Conversion Decision-Making Flow Chart**) have been developed for design managers and decision-makers. These flow chart graphics should be reviewed and used while completing the Decision-Making Form. These flow charts are intended to assist in the decision-making process of if the value of converting a project from SS2 to ORD is best suited for the project to continue moving forward.

> *The ROW ORD Conversion Decision-Making Flow Chart should only be referenced if a project falls within the ROW phase.*

Take Note!

Appendix A.2 ORD Conversion Decision-Making Flow Chart

ORD Conversion
Decision-Making Flow Chart

Existing Project

What **development phase** is the project in?

Yes ← Has the project been **surveyed**? → No

Survey team members should complete the **FUNDAMENTALS** and **SURVEY** ORD training manuals *(at a minimum).*

Start project in ORD beginning with survey

Preliminary Engineering

Right-of-Way (ROW)

Construction

Does the project have a confirmed **grade approval** and finalized **horizontal and vertical alignments**?

See Appendix A.2 *ROW ORD Conversion Decision-Making Flow Chart"*

Keep project files in MicroStation SS2

No

Yes

Develop a plan with the project team and ORD resources to convert project data based on intended use in ORD (e.g., 3D model for design). This could include, but not limited to, importing alignments from a GPK file and importing SS2 linework to control the 3D model.

No ← Does the project contain **ROW acquisition(s)?** → Yes

Convert project to ORD

Design team members should complete the **FUNDAMENTALS**, **ROADWAY DESIGN I, SUDA**, and **ROADWAY DESIGN II** ORD training manuals.

Utilize the **SS2 Standards.zip** to incorporate SS2 survey into the project workset.*

Reference the TDOT ORD website for additional information.

February 2024

Appendix A.3 ROW ORD Conversion Decision-Making Flow Chart
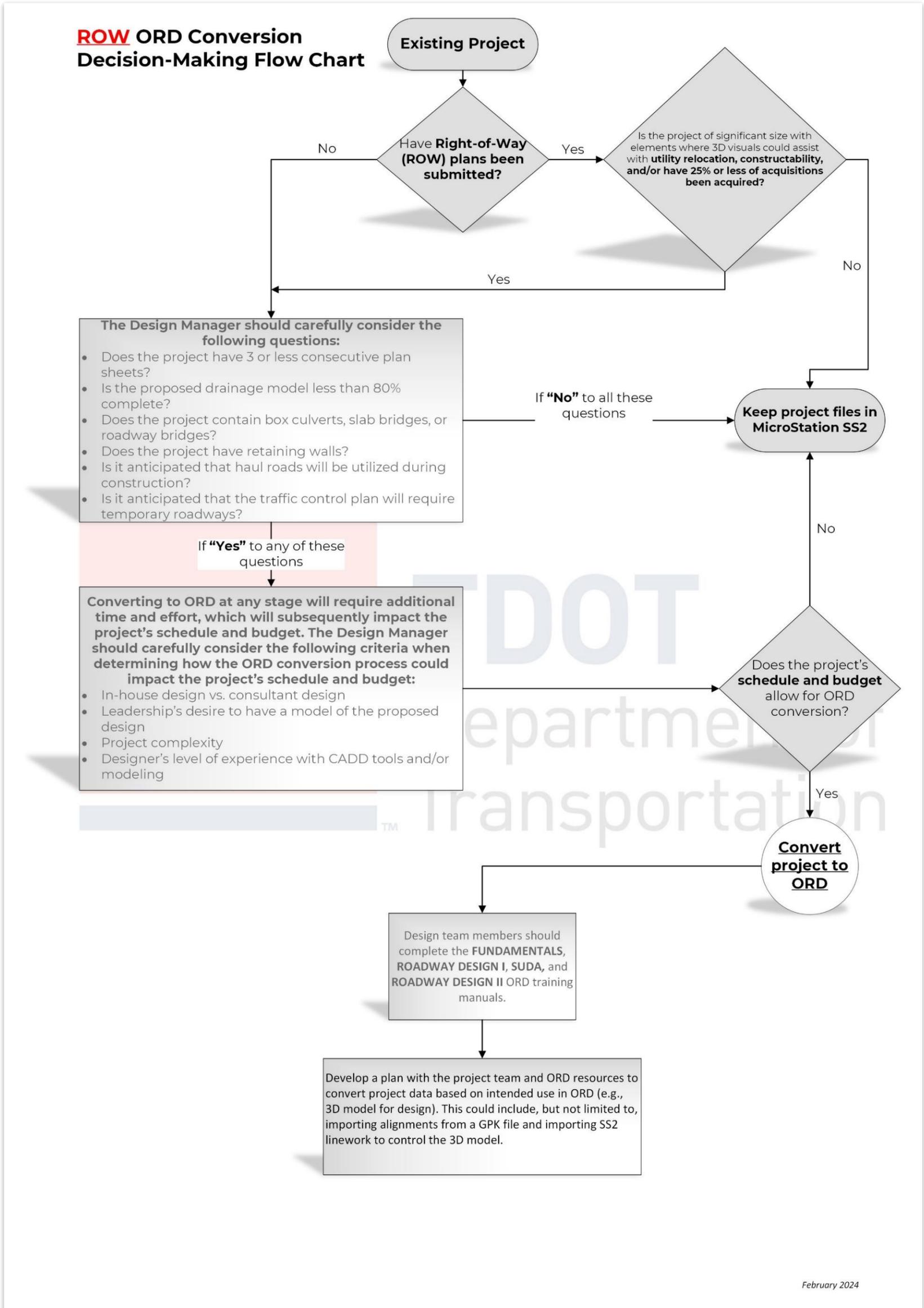
Appendix B. SS2 Survey Implementation into ORD

If utilizing an SS2 survey in an ORD project, you will need to incorporate the **SS2 Standards.zip** file into your project **workset** (located on the TDOT CADD Support website under **ORD Resources >> Additional Resources >> SS2 Survey Implementation**). This will allow the correct visualization of <u>all</u> 2D SS2 survey graphics and annotation. Once incorporated, you will see the applicable TDOT SS2 custom linestyles and be able to utilize the SS2 filters. The example workset created in this document is called **SS2 Survey Project**.

> *This process is intended for designers that have a complete SS2 survey. The process will be similar but different if a Survey was started in SS2, but office work was completed in ORD.*
>
> ***Take Note!***

1. Within **File Explorer**, open your project workset and paste the **SS2 Standards.zip** file into the main folder: **C:\ProgramData\Bentley\OpenRoads Designer XX\ Configuration\WorkSpaces\TDOT_Standards\WorkSets\SS2 Survey Project**. **Note:** For networked projects, the same location within the workset would apply.
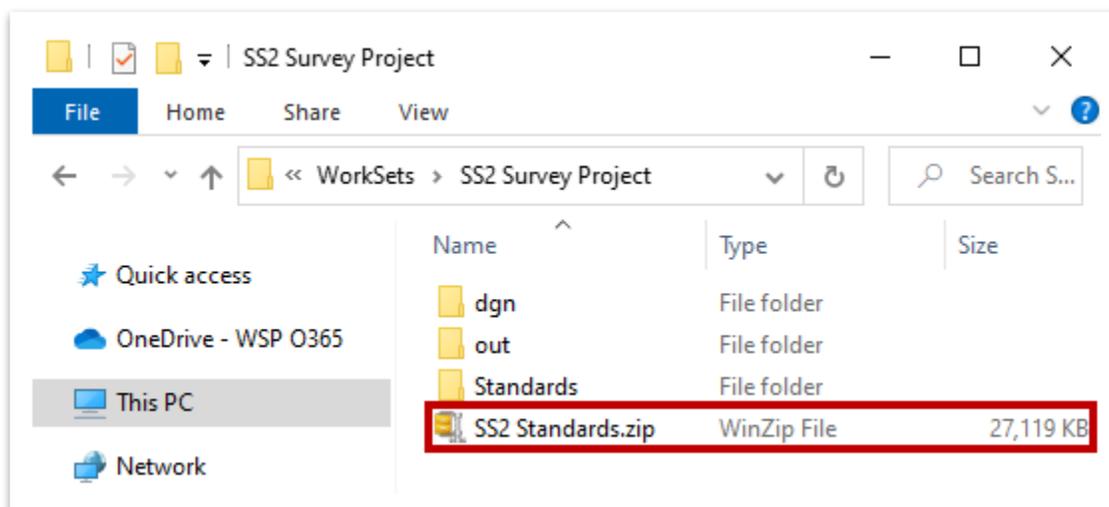
2. **Right** click on the zip file and select **WinZip >> Unzip to Here**. **Note:** If you don't have **WinZip**, use any zip extractor but make sure to unzip to the main workset folder. Once extracted, go ahead and delete the zip file.

3. Notice that the extraction placed the SS2 **dgnlib** (levels and filters) and three **.rsc** files (custom linestyles) into the applicable subfolders within the **Standards** folder. Any file opened or created under this **SS2 Survey Project** workset will now contain the necessary workspace elements to display the 2D SS2 survey elements properly.

Note: One of the caveats between SS2 and ORD is that utilization of some ORD levels (primarily survey) will be restricted when this file is unzipped, due to level number duplication. Essentially, if an ORD level has the same level number as the equivalent SS2 level, it will not be usable.

4. In order to utilize (and edit) the SS2 file in ORD, it needs to be uplifted into an ORD format using the **Civil File Manager** tool that is delivered with the ORD software. Open the tool using either method: (1) Browse to the **CivilFileManager.exe** file (**C:\Program Files\Bentley\OpenRoads Designer XX\OpenRoadsDesigner**), or (2) within ORD, go to **File >> Civil Tools >> Civil File Manager**. **Note:** For either option, make sure you open the tool in the ORD version that you want to uplift to.

5. Within the **Civil File Manager**, go to **File >> Open >> File**. Browse to the SS2 survey file that you want to use in ORD and click **Open**. **Note:** If multiple files needed to be uplifted at once, you would select the **Folder** option.
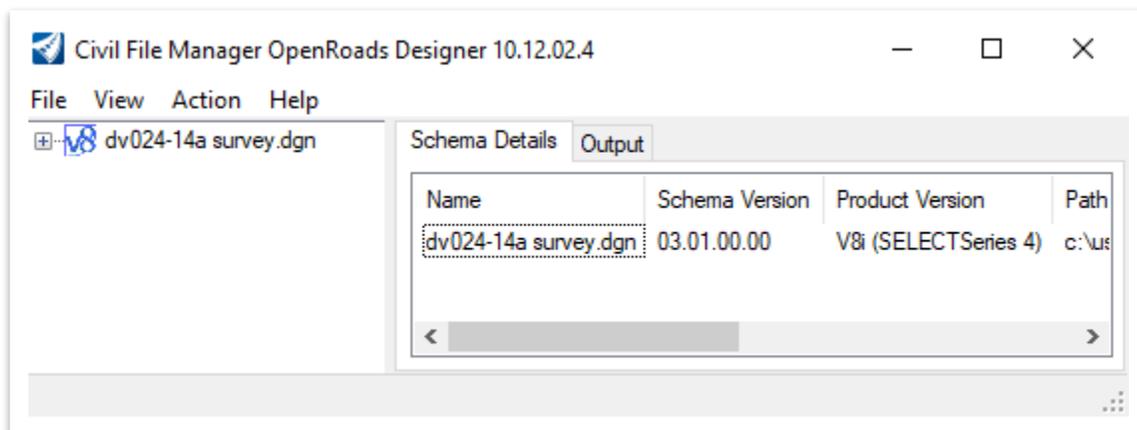
6. In this example, notice that the **Schema Version** and **Product Version** both indicate that the file was created in **SS4**, hence the need to upgrade so it can be edited in ORD. Go to **Action >> Upgrade All (Force)** to initiate the process.

7. Now, go back to the **Schema Details** tab and notice the **Schema Version** has changed, and the **Product Version** is now aligned with the Civil File Manager version. **Note:** Each version of ORD has a unique Civil File Manager. In this example, the Civil File Manager for ORD 10.12.02.4 was used; therefore the file is now 10.12.02.4.

8. Go ahead and open the file in ORD and assign it to the project workset. Notice that most elements are correct, because the SS2 zip file was utilized providing the applicable level and rsc files to the software.

9. Another caveat between SS2 and ORD is, if the custom linestyle name is not unique on both platforms, the ORD version and scale will override the SS2 version. There are currently **twelve (12)** SS2 survey linestyles that share the same name in ORD. While the correct linestyles appear in the SS2 survey file, the scale is incorrect.

    - Brush Line
    - City Line
    - County Line
    - Forest Line
    - Hedge
    - Property

    - Railroad
    - ROW Fence Ex
    - State Line
    - SUE Gas Line
    - SUE Water Line
    - Swamp Line

10. To change the scaling of these lines, turn off all survey elements other than the linestyle(s) that you want to scale. To apply a mass scale, there cannot be any **complex elements** or else you won't see the applicable field in the **Properties**. Line strings are also problematic, but you can still utilize them. However, you would scale all line strings separately from the lines. The simplest thing to do is select all and open the **Drop Element** tool (**Survey >> Drawing >> Groups**) and **left** click anywhere within the drawing window. **Note:** Use caution in doing this as it may affect the direction of the linestyle and affect the appearance.
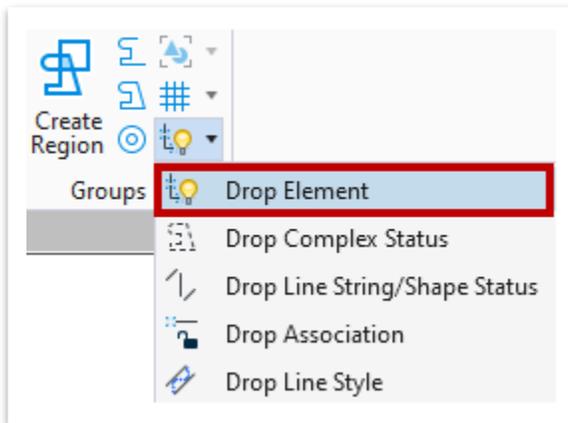
11. With the applicable lines still selected, open the **Properties** window (if not already open) and scroll down to **Extended >> Line Style Parameters >> Scale**. Change the scale to the desired value, based on your design scale. This example utilizes a 50 scale design, so a scale of **600** would be used. **Note:** A 20 scale design would use **240** and a 200 scale design would use **2400**. Also, if this file was to be referenced in a 200 scale design, a copy of this model would need to be created, and all linestyles would need to be scaled up.
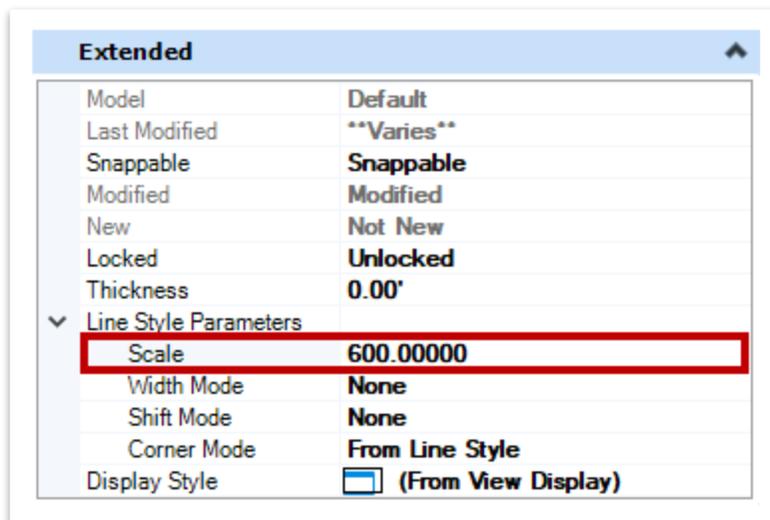
12. If you want to apply a **Filter** to the survey file, open the **Level Display** and highlight the file. Select **Filters** and notice that the applicable SS2 filters appear at the top of the list with an underscore. All ORD filters are listed further below.
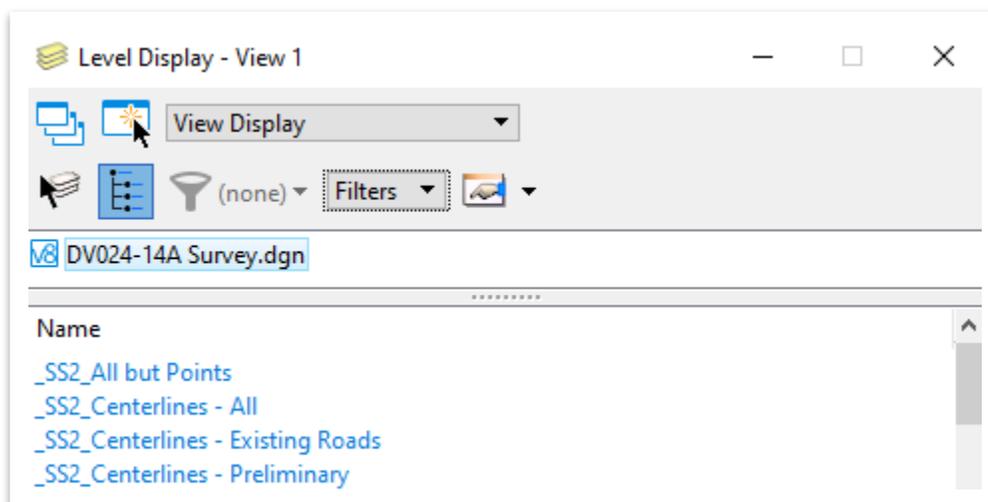
13. When referencing this file in other ORD files, **right** click on the survey reference file and select **Settings**. Within the **Attachment Properties**, change the **Global LineStyle Scale** from Master to **Reference** and then click **OK**.

Appendix C. Workspace Installation Guidance

The **Configuration.zip** file can be extracted from the TDOT CADD Support website within the **ORD Resources** section under **Support Files**. The referenced zip file will be located within the **TDOT ORD Workspace** link, as shown in the image below.

Within the configuration folder, there is an **Organization-Civil** folder. It contains a **TDOT_Standards** folder and a **TDOT_Standards.cfg** file which contain the workspace setup. These files should not be touched or edited.

The TDOT configuration folder should be extracted to the following location and delete and **REPLACE** the default Bentley configuration folder: **C:\ProgramData\Bentley\Open Roads Designer XX**. You should see the folders below if done correctly.
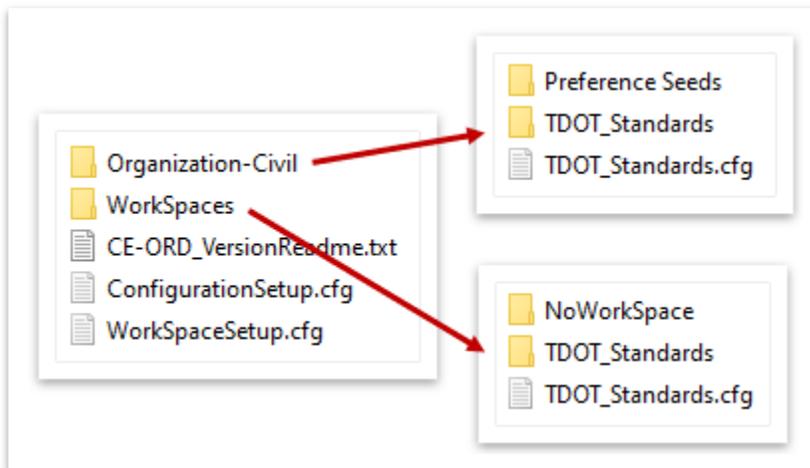
Once the user launches ORD, they should only see the TDOT workspace option (**TDOT_Standards**) and then be able to create a new Workset.
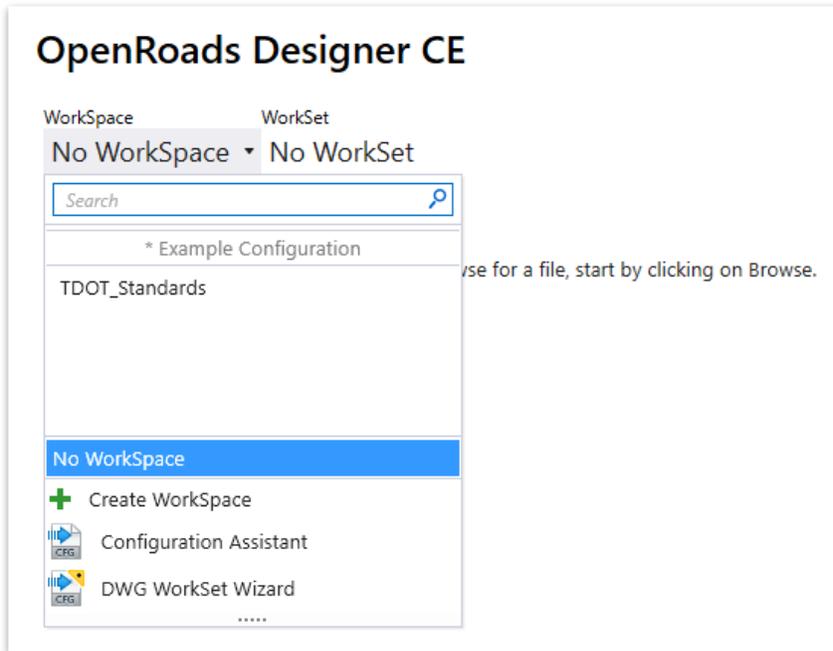
	Be sure to make a copy of your existing MicroStation V8i (SS2/SS10) dgn file(s) if you plan to open them in ORD. Information may be lost as some aspects of ORD files are not reverse compatible with MicroStation SS2/SS10 files.
Take Note!	

Appendix D. Survey Deliverables Process

ORD Survey (NEW Projects)

Creating ORD Survey Deliverables for Design*

*For Survey, a 3D DGN model should be used (except for the alignment and utility models), and survey files segregated from other design files. Survey data can be processed in a 2D model; however survey data, by its nature, is 3D and thus natural to use 3D models. More importantly by using 3D models, the user can take advantage of visual cues to analyze potential errors in the terrain model.

**Only required if scope includes aerial survey.

Aerial Survey Data *(Aerial Model.dgn)***

- Create **3D** Seed File and Assign Geographic Coordinate System
- Import Aerial Survey Data
- Create TIN File and Delete Boundary
- Annotate and Analyze Aerial Survey Data

Aerial Model.dgn Deliverable

Field Survey Data *(Model.dgn)*

- Create **3D** Seed File and Assign Geographic Coordinate System
- Review and Import Text Files (edit as necessary)
- Create TIN File and Delete Boundary
- Create Additional Survey Features (as necessary)
- Annotate and Analyze Survey Data

Combine TIN Files ****

Same TIN File ***

Model.dgn Deliverable

Terrain Model *(Terrain.dgn)*

- Create **3D** Seed File and Assign Geographic Coordinate System
- Create Existing Terrain Model (import TIN file (s))
- Reference Aerial Model.dgn File (only if required) and Model.dgn File for Conformance

Terrain.dgn Deliverable

Preliminary Geometry *(Alignment.dgn)*

- Create **2D** Seed File and Assign Geographic Coordinate System
- Import Applicable Text Files
- Create Preliminary Centerline Horizontal Alignment with Profile
- Add Existing Right-of-Way and Property Data
- Project Existing Drainage and Utilities on Preliminary Centerline Profile (once Utility.dgn is completed)
- Create Profile Named Boundary and Annotate

Alignment.dgn Deliverable

Utility Model *(Utility.dgn)*

- Create **2D** Seed File and Assign Geographic Coordinate System
- Reference the following files: Aerial Model.dgn (only if required) Model.dgn Terrain.dgn Alignment.dgn
- Create Existing Drainage Model with Delineated Drainage Areas
- Create Existing Utility Model
- Annotate Drainage and Utility Models
- Complete Drainage/ Hydraulic Data Blocks

Utility.dgn Deliverable

Deliver DGN Files to Design

***Model.dgn TIN should be used to create Terrain.dgn, if Field Survey Data is only scoped.

****Aerial Model.dgn TIN should be combined with Model.dgn TIN to create Terrain.dgn, if Aerial Survey Data and Field Survey Data are both scoped.