CADD Manual

March 2026

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Chapter 1 - Introduction

1.1 Purpose

The CADD Manual provides the standards, procedures, and technical requirements for using Computer Aided Design and Drafting (CADD) software in the development and delivery of digital project data for the North Carolina Department of Transportation (NCDOT). Beyond software and system configuration requirements, the CADD Manual defines the tools, methods, applications, standards, and workflows necessary to deliver a consistent, high-quality CADD product for the Department.

The CADD Manual sets forth *minimum* CADD standards to promote uniform, reliable, and repeatable CADD data across all Department projects. In addition, it provides guidance for professional services administrators, project managers, consultants, in-house designers, and other stakeholders, and may be incorporated by reference into scopes of work and contractual documents. This shift toward more consistent data across all projects will promote better quality, accuracy, and consistency in NCDOT project delivery. It is also meant to facilitate collaboration, reduce misunderstandings, and enhance overall efficiency of design processes.

1.2 Authority

This manual is issued under the authority of the North Carolina Department of Transportation and the North Carolina Department of Information Technology – Transportation (NCDIT-T). The standards and processes described herein establish required practices for CADD usage across all NCDOT Engineering Design Units, Divisions, and participating consultants.

For more information, see North Carolina General Assembly Statute 136-18.

1.3 References

This manual incorporates references to NCDOT policies, CADD standards, design guidelines and manuals, and software documentation. Users must consult the latest version of all referenced materials when applying the guidance in this document.

1.4 CADD Glossary of Terms

Definitions for CADD, modeling, data management, and related terminology are provided in the CADD Glossary of Terms. Users should review these terms to ensure consistent interpretation and application of standards throughout project development.

1.5 Scope

This manual applies to all NCDOT staff and external partners who use CADD software to develop, review, or deliver digital design data and project documents. It covers required practices from conceptual design through construction and includes guidance for digital workflows, file management, software usage, and CADD deliverables. The CADD Manual is to be referenced in contracts requiring engineering plans and 3D Models preparation utilizing CADD. This manual affects all offices of the Department and all consultants, contractors and others who utilize CADD applications.

1.6 Roles and Responsibility

The following groups support the development, maintenance, and implementation of NCDOT CADD standards and workflows.

1.6.1 CADD Support Services Team

The CADD Support Services (CSS) Team is a part of NCDOT Technical Services' Program Support Unit.

The CADD Support Services Team:

- Maintain ownership and administrative responsibility for the CADD Manual, including all standards, policies, procedures, and revisions.
- Develop, publish, and maintain CADD standards, the NCDOT WorkSpace, templates, and design libraries.
- Ensure consistent implementation and application of all approved CADD standards and manuals across the Department.
- Provide technical leadership and coordination for CADD Coordinators.
- Deliver training and technical support to all units, divisions, and consultants to ensure compliance with established standards and data integrity requirements.
- Monitor adherence to CADD standards and facilitate updates to maintain alignment with evolving technologies and departmental needs.

1.6.2 CADD Innovation Team

The CADD Innovation Team (CIT) is a part of NCDOT Technical Services' Program Support Unit.

The CADD Innovation Team:

- Lead the development, advancement, and strategic support of the Department's Digital Delivery program.
- Establish and promote best practices, standards, and guidance for the NCDOT WorkSpace, CADD/BIM implementation and solutions.
- Collaborate with EDCS, software vendors, peer agencies, and industry partners to position the Department at the forefront of Digital Delivery practices.
- Evaluate emerging technologies and workflows; provide recommendations to leadership regarding software selection, implementation strategies, and associated risks.
- Keep management informed of project delivery impacts and financial risks related to Digital Delivery tools and methodologies.

1.6.3 CADD Coordinators

CADD Coordinators are subject-matter experts for their respective units.

CADD Coordinators:

- Serve as the primary CADD point of contact within their unit or division, representing discipline needs, standards, and workflows.

- Support WorkSpace development and implementation of approved CADD standards and tools, including developing discipline specific WorkSpace resources.
- Provide discipline-specific input, testing, and feedback to ensure CADD solutions are practical and effective for real project delivery.
- Support adoption and compliance by communicating updates, assisting staff, and reinforcing approved CADD practices within their areas.
- Identify issues, risks, and improvement opportunities related to CADD workflows and escalate them through established coordination channels.

A directory of discipline specific CADD Coordinators can be found at this link: NCDOT CADD Coordinator Contacts

1.6.4 Engineering Design & CADD Services (EDCS)

The Engineering Design and CADD Services (EDCS) Unit, within the North Carolina Department of Information Technology (NCDIT), provides statewide hardware, software, and WorkSpace support for all engineering and CADD users.

EDCS:

- Provides enterprise-level CADD and engineering design system support for NCDOT to ensure stability, security, and performance of approved design platforms.
- Manages and maintains core CADD infrastructure and environments, including software deployment, configuration, and version control.
- Partners with the CADD Innovation Team and discipline stakeholders to support implementation of standards, WorkSpaces, and workflows.
- Supports issue resolution and system troubleshooting to minimize disruptions and maintain continuity for active projects.
- Ensures alignment with NCDIT policies and IT governance while enabling NCDOT's evolving Digital Delivery needs.

EDCS also supports related engineering systems such as HiCAMS, SPECS, and ECM.

1.6.5 Contact Emails

For interdisciplinary workflow questions, contact **CIT@ncdot.gov**.
For CADD Software support and questions, contact **cadd-sup@ncdot.gov**.
For WorkSpace questions, contact **workspace@ncdot.gov.**
For ProjectWise questions, contact **dot.pwsupport@ncdot.gov.**

1.7 Distribution

This manual is distributed electronically to NCDOT staff, consultants, and other authorized partners involved in project development. The most current version is available on the CADD Innovation Team webpage. Users are responsible for accessing the latest published version when performing CADD-related work.

1.8 Revisions and Updates

This manual will be updated as needed to incorporate software changes, workflow improvements, and user feedback. Each update may include revised procedures, clarified guidance, or added standards. Users should review the revision summary provided with each release to understand changes.

1.9 Disclaimer

This manual is published by the North Carolina Department of Transportation (NCDOT) for informational use. It is not for resale or commercial distribution.

NCDOT makes no expressed or implied warranty regarding the accuracy of the information contained in this manual or any associated files. Users are responsible for ensuring they are working with the most current version of the document and associated standards.

NCDOT assumes no liability for losses, damages, claims, or expenses resulting from the use of any information or files referenced in this manual. By using this manual, the user accepts these terms.

1.10 Online Resources

This section provides access to key online resources used throughout NCDOT's CADD workflows. Users should reference the most current versions of all materials when preparing project deliverables.

- NCDOT Project Delivery Network (PDN)
  Provides a standardized framework for project delivery by defining stages, activities, tasks, deliverables, and references. The PDN promotes consistency, transparency, multidisciplinary coordination, streamlined workflows, and systematic quality control and assurance throughout project development.
- NCDOT CADD Innovation Team Webpage
  Provides CADD guidance documents, a directory of CADD Coordinators, and additional CADD-related resources.
- NCDOT ORD Service Portal (ServiceNow) – Requires NCID log in
  Serves as the central portal for submitting CADD and ORD support requests, accessing knowledge articles, and viewing available training materials.
- EDCS CADD Consultants Resources Webpage
  Offers consultant-specific resources, including WorkSpace tools, configuration updates, and downloads for the CADD environment.
- NCDOT ProjectWise Webpage
  Explains NCDOT's use of ProjectWise and provides instructions for accessing, managing, and navigating ProjectWise work areas.
- NCDOT Digital Delivery Webpage
  Contains information on NCDOT's Digital Delivery initiatives, policies, and supporting guidance documents.

Chapter 2 - CADD Hardware and Software

This chapter establishes the hardware, software, and platform requirements that support NCDOT's CADD environment. It identifies recommended workstation specifications, approved CADD software and versions, and required configurations for ProjectWise and OpenX used for project delivery. These requirements promote dependable system performance, consistent file management, and interoperability across NCDOT disciplines and external partners.

For questions or comments please email CADD Support at CADD-sup@ncdot.gov.

2.1 CADD Hardware and Software

NCDOT establishes minimum hardware and software recommendations to support consistent performance across CADD applications. These specifications are based on industry standards, system performance requirements, and NCDOT's embrace of 3D modeling and Digital Delivery workflows. They will be updated as needed. Users are responsible for maintaining systems capable of supporting current CADD software and WorkSpace configurations.

2.1.1 CADD Hardware Specifications

NCDOT does not endorse specific hardware manufacturers. Updated specifications are published on the CADD Standards webpage.

2.1.2 CADD Software Versions

NCDOT maintains and publishes a list of approved CADD software versions on the CADD Standards webpage. This includes a list of current OpenX versions and other commonly used software for project delivery.

2.2 Connect NCDOT (SharePoint Website)

Connect NCDOT is a SharePoint website and it serves as NCDOT's central location for all project file storage. Support and Help for using SharePoint can be found at the SharePoint Help webpage.

2.3 ATLAS

ATLAS is a tool that supports a project's Connect NCDOT SharePoint website. Guidance for ATLAS can be found on the ATLAS Resources webpage.

2.4 ProjectWise

ProjectWise is NCDOT's authorized platform for storing, managing, and collaborating on CADD project files. It provides controlled access, version management, and standardized WorkSpaces for both NCDOT staff and consultants.

2.4.1 Work Areas

A ProjectWise Work Area serves as the central directory for all project-related CADD files. Each project will have its own unique project Work Area.

Some existing projects that have a Connect NCDOT SharePoint website may not have a ProjectWise Work Area set up. For those projects, the NCDOT project manager should email dot.pwsupport@ncdot.gov to have a ProjectWise Work Area created.

When new project sites are created on Connect NCDOT (SharePoint), a Work Area for that project will be created in ProjectWise with the same name and description.

2.4.2 Managed and Unmanaged WorkSpaces

A project's Work Area automatically has the NCDOT managed WorkSpace attached to all project folders. This WorkSpace is maintained by NCDOT and ensures projects have consistent feature definitions, templates, seed files, and standards.

Consultants are required to use the NCDOT ProjectWise Work Area with the managed WorkSpace when submitting electronic files to NCDOT for review. Consultants may use this NCDOT ProjectWise Work Area and managed WorkSpace while working in design files for the development of a submittal, but NCDOT does not require consultants to keep active design files on NCDOT's ProjectWise server. If a Consultant chooses not to use the NCDOT's ProjectWise server while developing designs, they are responsible for the data per contract requirements.

NCDOT provides the latest WorkSpace for download on the CADD Workspace webpage. This unmanaged WorkSpace can be used by consultants when developing designs somewhere other than NCDOT's ProjectWise server. Consultants are responsible for maintaining their local WorkSpace.

2.4.3 Work Areas and Folder Structures

The folder structure for each Work Area will match the folder structure template that was in place at the time the Work Area was created. The latest NCDOT ProjectWise Folder Structure can be found in Section 3.5.1.

If a project's current folder structure doesn't match the latest NCDOT ProjectWise Folder Structure, NCDOT project managers and consultants should work together with the ProjectWise Support Team to get their project's folder structure updated.

Any requests to change the standard NCDOT ProjectWise Folder Structure should be coordinated with the ProjectWise Support Team. Changes to the standard ProjectWise Folder Structure listed in Section 3.5.1 must be approved by the Director of Technical Services. See Section 3.5.2 for more information on creating custom subfolders.

2.4.4 File Management and Backup Procedures

ProjectWise performs routine backups and provides restoration options for deleted or corrupted files.

Files deleted within the last 180 days may be restored by contacting the ProjectWise Support Team. No Bentley service ticket is required for this recovery method.

Backups of files are retained on a 30-day rolling schedule and can be restored by contacting the ProjectWise Support Team. Restoring a backup file will require the ProjectWise Support to submit a service ticket to Bentley.

2.4.5 Consultant Access Management and Authorization

Consultants will need to register and authenticate their credentials through Bentley's Connection Client to access NCDOT's ProjectWise data source. Instructions on how to access the NCDOT data source can be found on the NCDOT ProjectWise webpage.

Consultants will also need to submit an access request to the ProjectWise Support team to receive authenticated access to specific ProjectWise Work Areas. The request form can be found on the NCDOT ProjectWise webpage. Access permissions are limited to the specific Work Areas for each project the Consultant will be working on.

2.4.6 ProjectWise Support Team and Updates

The ProjectWise Support Team supports configuration, maintenance, and user access for ProjectWise systems.

- **ProjectWise Support Email:** dot.pwsupport@ncdot.gov

There is also a list of Frequently Asked Questions on the NCDOT ProjectWise webpage.

EDCS implements periodic ProjectWise updates and patches. EDCS is also investigating ProjectWise Drive and Project Wise 365 for use on future projects. More information on these changes and updates can be found on the NCDOT ProjectWise webpage.

Project Store, also identified as ProjStore, is a legacy internal file storage system used historically by NCDOT to house project documents and CADD files within the DOT network environment. Due to its internal-only access model and file-based architecture, Project Store does not support the collaborative, model-based and cloud-based workflows required for project delivery. As NCDOT advances toward model-based workflows and external partner integration, Project Store will be phased out in favor of structured, collaborative digital platforms like ProjectWise. This shift aims to centralize document workflows, enhance data security, and provide easier access to current project files within a single platform.

2.5 Bentley OpenX Software

NCDOT uses the Bentley OpenX suite to support civil design, modeling, analysis, and project documentation. OpenX applications integrate with ProjectWise and NCDOT's WorkSpace to ensure consistent digital design workflows across disciplines.

OpenX Designer has multiple software products that provide capabilities for roadway, bridge, rail, geotechnical, and other discipline-specific designs.

2.5.1 OpenRoads

OpenRoads Designer (ORD) is NCDOT's primary software for roadway and other discipline-specific designs.

NCDOT Units Using ORD

- Location & Surveys
- Photogrammetry

- Feasibility Studies
- Roadway
- Hydraulics
- Utility Coordination and Design
- Traffic Management
- Signing and Delineation
- Roadside Environmental
- Roadway Lighting
- Rail Division
- Transportation Signals and ITS
- Environmental Analysis Unit

2.5.2 OpenBridge

OpenBridge Designer (OBD) combines bridge modeling, analysis, and design tools in a single integrated application. It incorporates OpenBridge Modeler for 3D parametric modeling, LEAP Bridge Concrete, LEAP Bridge Steel, and RM Bridge for analysis and design, and supports load rating, quantities, and geometric reporting. OpenBridge integrates with OpenRoads Designer and ProStructures to support interdisciplinary workflows.

NCDOT Units Using OBD

- Structures Management Unit

2.5.3 OpenRail

OpenRail Designer (ORL) provides tools for rail corridor design, including geometry, turnouts, and regression analysis. NCDOT's Rail Division is currently evaluating ORL through pilot projects to determine WorkSpace needs and recommended guidelines.

NCDOT Units Using ORL

- Rail Division

2.6 OpenX Project Versions

2.6.1 OpenX Version and WorkSpace Policy

NCDOT previously provided a WorkSpace structured by roles corresponding to NCDOT Design Units. This NCDOT Role-Based WorkSpace was refined and released with Bentley's OpenX versions 10.10, 10.12, and 2023.

In March 2026, NCDOT released a new Unified WorkSpace for Bentley's 2024 versions of its OpenX Design Products (OpenX 2024). This Unified WorkSpace eliminates the previous role-based structure, enabling NCDOT to more efficiently adapt to future OpenX releases and advance its Digital Delivery objectives.

On August 2, 2023, the Director of Technical Services issued a memorandum requiring all new projects to begin in OpenX. The memorandum also provided guidance on which ongoing projects should transition from SS2/SS4 to OpenX. Project Managers are responsible for ensuring that a project's WorkSpace and OpenX version comply with the latest policy.

Beginning in March 2026, all new projects must begin in the Unified WorkSpace using OpenX Version 2024.

Project teams may transition existing projects into the Unified WorkSpace in OpenX Version 2024. Additional guidance for how to perform this transition is provided in Section 2.6.2 and Section 2.6.3.

Future guidance will be issued identifying which existing projects are required to upgrade to the Unified WorkSpace in OpenX Version 2024.

2.6.2 How to upgrade existing OpenX projects to the Unified WorkSpace in OpenX 2024

Upgrading refers to the process of moving a file created in an earlier version of OpenX into a newer version of OpenX. Upgrading maintains the file within the OpenX platform while updating it to the current software version. The **NCDOT OpenX 2024 Project Upgrade Procedures** describes how to upgrade existing OpenX projects to the Unified WorkSpace in OpenX 2024.

2.6.3 How to convert existing SS2 projects to the Unified WorkSpace in OpenX 2024

Conversion refers to the process of transitioning design files originally developed in MicroStation/Power GEOPAK (SS2/SS4) into OpenX. Conversion involves moving legacy design data from the MicroStation environment into the OpenX platform. The **NCDOT OpenRoads Designer (ORD) SS2 to ORD CADD Conversion Guide** provides guidelines for converting GEOPAK SS2/SS4 or Power GEOPAK SS4/SS10 roadway project data into ORD. If a SS2 or SS4 project is converted, it should be converted into the Unified WorkSpace in OpenX 2024.

2.6.4 CADD File Guidance for when a project is placed on hold

The **NCDOT CADD File Guidance for Projects On Hold** provides guidance on what steps must be taken if a project is placed on hold.

2.7 OpenX Support

The ORD Service Portal (ServiceNow) provides:

- A searchable knowledge base for ORD and CADD topics
- Access to training materials
- A system for submitting support requests
- Announcements and updates related to CADD tools

The portal improves how users troubleshoot issues, share solutions, and access technical information previously exchanged primarily through email.

The **NCDOT ORD Training Resource Document** consolidates key training materials that may be helpful for users.

2.8 CADD Software Development

CADD software development activities are managed by EDCS and include updating Department-specific applications, adding functional enhancements to existing software, and performing routine maintenance. Development efforts are driven by identified needs and may involve internal development, contracted services, or the acquisition of commercially available software when appropriate.

Requests for CADD software enhancements or new capabilities are submitted to CSS, EDCS, or CIT by CADD Coordinators and members of the CADD user community. EDCS also identifies software needs based on support activities, user feedback, and emerging trends within the CADD industry.

All development requests are overseen by EDCS and coordinated with the CADD Innovation Team, NCDOT Design Units, CADD coordinators, and information technology staff supporting CADD systems. EDCS determines the most appropriate delivery method for each request, including in-house development, external contracting, or commercial procurement.

2.9 CADD Software Updates

CSS and CIT, in collaboration with NCDOT design units, CADD Coordinators, EDCS, and the broader CADD user community, establishes and maintains the Department's CADD standards used for CADD production and related activities. These standards are implemented through NCDOT's CADD software, and the CADD Manual is maintained in coordination with the software to document and communicate applicable requirements.

NCDOT's CADD software is updated as necessary to incorporate platform version upgrades, revised or new resource files, and enhancements to custom tools developed since the previous release. All software updates are reviewed, tested, and formally approved by CSS, CIT, and EDCS prior to release. NCDOT will maintain and provide updates only for the most current NCDOT WorkSpace and OpenX software version. Support and updates for prior versions will not be provided.

EDCS conducts internal testing of new or revised CADD software during development in advance of scheduled releases. For significant updates, user-based testing may also be conducted prior to deployment. Participation in such testing is performed by the CADD Coordinators, in coordination with CSS, CIT, and EDCS support staff.

CSS and CIT are responsible for coordinating the release of scheduled CADD software updates and maintenance releases, including notifying appropriate personnel when new versions are available. Distribution of approved software to end users is performed by CSS and CIT in coordination with EDCS. Department CADD software and related resources, including documentation for the latest WorkSpace updates, are made available on the EDCS webpage.

Chapter 3 - CADD Standards

3.1 General

Bentley OpenX is NCDOT's only authorized CADD Software platform. CSS, CIT, and EDCS manage and coordinate CADD Standards through customizations within NCDOT's Unified OpenX WorkSpace for the development of digital design files and production of transportation plans.

NCDOT's Unified OpenX WorkSpace includes standard design libraries to propagate the CADD Standards definitions of levels and symbology (color, line styles, weights), multi-line styles, text styles, dimension styles, cells, menu customizations, customized tools, tool groups, and tasks.

OpenX Environment Structure

The NCDOT Unified OpenX WorkSpace environment is organized into three primary layers: Organization-Civil, WorkSpaces, and WorkSets. Each layer serves a specific purpose and understanding the differences can help users know where standards originate and where project resources belong.

The **Organization-Civil layer** contains the official NCDOT standard libraries. This is where statewide levels, symbology, cells, text styles, dimension styles, Feature Definitions, Item Types, and other approved configuration content are stored. Organization-Civil represents the authoritative NCDOT standards and should not be modified by consultants.

The **WorkSpaces layer** allows for consultant modifications to the NCDOT environment. This layer is intended for firm-managed standards, tools, or resources that may be needed across multiple NCDOT projects, provided they do not override or conflict with Organization-Civil standards. The WorkSpaces layer's primary function is to control how the Bentley software behaves for a user's external organization. This folder has the ability to control or enhance items such as configuration variables, custom toolboxes and ribbon setups, reporting formats, macros and customizations, etc. The WorkSpaces layer does not replace NCDOT standards and should not be used to alter statewide definitions. Configuration within this layer should be managed by CADD administrators who understand OpenX configuration and NCDOT requirements.

The **WorkSets layer** is where project-specific elements are stored. It supports project folders, project standards, and project resources that apply only to an individual project. The WorkSets layer allows teams to organize and manage project content without modifying statewide libraries.

For detailed configuration and administrative documentation of the NCDOT OpenX environment, including variable structure and standards implementation, refer to the NCDOT WorkSpace Configuration Reference Documentation. (This link requires access to ProjectWise. This document can also be found within the zipped WorkSpace which can be downloaded from the EDCS CADD WorkSpace webpage.)

3.2 Database Resources

OpenX software utilizes Item Types and Feature Definitions as key components in the design process. Feature Definitions control Display Levels, Symbology, and other graphical properties, defining how

features are represented in drawings and models. Item Types not only apply Pay Item information for quantities but can also capture additional project data, such as NBI elements and other attributes that can be shared with inspection and reporting software. By leveraging Item Types in this way, designers can ensure that design models carry both visual and data-rich information to support downstream workflows. Future releases of the CADD Manual will provide guidance on best practices for when and how Item Types should be applied to maximize consistency and utility throughout the design process.

3.3 Seed Files

The NCDOT WorkSpace provides standard seed files used at the time of file creation to establish base configuration such as units, models, symbology, and required settings. These seed files ensure consistency across disciplines and projects and should be selected based on the project scope and deliverable requirements when a new design file is created.

Core Seed Files

Core seed files are the primary seed files used to create new design files and establish standard project configuration for each software platform, including units, models, level structures, and base symbology.

Table: Core Seed Files Available in the NCDOT WorkSpace

Core Seed Filename	Description
Seed2D – English Design.dgn	Standard OpenRoads Designer 2D Design Seed File
Seed3D – English Design.dgn	Standard OpenRoads Designer 3D Design Seed File
Seed2D – English Rail Design.dgn	Standard OpenRail Designer 2D Design Seed File
SMU OBM-Seed2D.dgn	Standard OpenBridge (OBM) 2D Design Seed File
SMU OBM-Seed3D.dgn	Standard OpenBridge (OBM) 3D Design Seed File

Discipline-Specific Seed Files

Discipline-specific seed files are provided to support discipline-owned workflows that extend or supplement standard project configuration. These files do not replace core seed files and are managed by individual Units based on their specific production needs.

The specific timing and method of use for discipline-specific seed files is defined by the applicable discipline documentation and workflows.

Seed File Usage

Correct seed file usage ensures standardization of units, scale, templates, level structures, and model configurations across all NCDOT projects. Using an incorrect seed file can result in inconsistent behavior or issues with downstream workflows, including automated processes such as WorkSet branding.

Selecting the correct seed file at the time of file creation helps ensure that standard configurations and workflows function as intended.

Seed File Locations

Seed files are stored in the OpenX WorkSpace under the following directories:

- NCDOT_CONNECT_WORKSPACE\Configuration_2024\Organization-Civil\NCDOT\Seed
- NCDOT_CONNECT_WORKSPACE\Configuration_2024\Organization-Civil\NCDOT\Seed\Discipline

Note: Some OpenX applications, such as OpenBridge Modeler, use software-specific seed file locations to support application configuration. These seed files serve the same foundational purpose as core seed files.

3.4 Working Units and Global Origin

Survey Foot is the required and standard working unit for all NCDOT English design files created from standard NCDOT seed files. Consistent use of Survey Foot is required to ensure accurate coordinates, alignments, and reference file behavior across all project files and disciplines.

Incorrect or inconsistent unit definitions can result in alignment discrepancies, coordinate shifts, and referencing issues that may not be immediately apparent but can affect downstream workflows, including sheet layout and plan production.

OpenX workflows assume the design file global origin is set to **(0,0).** Files created using standard NCDOT seed files meet this requirement by default.

Legacy files or consultant-delivered files created with non-zero global origins or incorrect unit settings may not exhibit immediate issues but can cause alignment, referencing, or sheet layout problems later in the project lifecycle. Verifying both working units and global origin prior to design production helps prevent downstream issues.

3.4.1 NCDOT OpenRoads and Open Rail Seed File Working Units

The standard NCDOT English design seed files for OpenRoads and OpenRail use the following working unit configuration:

Master Unit: US Survey Feet
Sub Unit: US Survey Tenths
Accuracy: 0.1234
Resolution: 10,000 per US Survey Foot

3.4.2 NCDOT OpenBridge Seed File Working Units

The standard NCDOT English design seed files for OpenBridge maintain Survey Foot as the master unit but use inch based sub units and increased precision to support structural detailing and dimensioning workflows.

Master Unit: US Survey Feet
Sub Unit: US Survey Inches
Accuracy: 1/16
Resolution: 10,000 per US Survey Foot
Geographic Coordinate System: NAD 1983 State Plan North Carolina FIPS 3200 feet

3.5 Folder Structure

NCDOT's projects are organized into a standardized folder structure within ProjectWise designed to support consistent project configuration, resource access, and file management across all disciplines. The structure ensures that users operate with the correct design libraries, feature definitions, templates, and WorkSpace settings.

A future release of the CADD Manual will provide more detail on the standard folder structure.

For more information on the Folder Structure in ProjectWise, see Section 2.4.3.

3.5.1 Standard Folder Structure

This is the NCDOT Standard Folder Structure:

1 _PWSetup
2 Alignment
3 Common
4 Congestion Management
5 Construction Revisions
6 Drainage
7 Environmental Analysis
    7.1 Archaeology
        7.1.1 Biological Surveys
        7.1.2 Environmental Coordination and Permitting
        7.1.3 Historic Architecture
        7.1.4 Mitigation and Modeling
        7.1.5 Monitoring and Stewardship
    7.2 Public Involvement-Community Studies-Visualization
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        7.2.2 Public Involvement
        7.2.3 Visualization
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    9.1 GeoEnvironmental
    9.2 GeoPavement
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25.1.2.6 Texts

3.5.2 Custom Subfolders

In certain situations, project teams may need to establish custom or non-standard subfolders to further organize work activities. This is typically necessary when multiple teams are working within the same component or discipline. Additional subfolders may be created within the applicable standard component or discipline folders but shall not be created directly under the root folder for the project.

3.6 File Naming

NCDOT applies standardized file naming conventions to promote consistency, clarity, and effective file management across all disciplines. These conventions facilitate coordination among units, improve file retrieval, and support organized project data within ProjectWise and local WorkSpaces. File names also communicate key information about the content of design files to downstream users.

Duplicate CADD design file names are not permitted within a project folder structure. This requirement is critical to maintaining proper reference attachments between CADD files. When resolving reference attachments, the software search sequence uses the first matching filename encountered when no path is defined. As a result, duplicate source filenames can lead to incorrect attachments and data integrity issues. References shall be attached using the *relative path* option only; the use of *full path* or *no path* options is not allowed.

NCDOT is moving towards more standardization in file naming convention. More guidance on file naming will be released in a future version of the CADD Manual.

3.7 Design Libraries

Design libraries provide the standardized resources used to support consistent modeling and drafting across all NCDOT OpenX projects. These standards are delivered through WorkSpace-loaded standards libraries (DGNLIB files) and are centrally managed to ensure uniform application across all disciplines.

Discipline specific standards are applied through WorkSpace libraries and templates rather than embedded directly within individual project files. This approach ensures consistency, simplifies updates, and prevents project-level overrides of approved standards.

Design libraries may contain multiple resource types, including feature definitions, levels, cells, text styles, dimension styles, and templates. Users generally do not interact directly with the library files themselves. Instead, standards are applied automatically through OpenX tools and workflows or selected from approved resources as part of normal design activities.

Users must apply the appropriate library and template components when creating new models or design elements to maintain consistency across project files. Custom resources at the WorkSet or project level are restricted and must follow NCDOT standards and governance.

Detailed guidance for specific resource types is provided in the following sections:

- Feature Definitions (Section 3.8)
- Levels (Section 3.9)
- Cell Libraries (Section 3.10)
- Text (Section 3.11)
- Dimension Styles (Section 3.12)

3.8 Feature Definitions

Feature Definitions establish the standardized attributes, behaviors, and rules applied to civil elements within OpenX applications. They are the primary mechanism used to apply NCDOT design standards and ensure consistent modeling, annotation, and visualization across all disciplines. Feature Definitions control how elements are created and managed, including level assignment, symbology, annotation behavior, surface and volume processing settings, and 2D and 3D display characteristics.

Feature Definitions are applied automatically through OpenX tools and workflows when creating new civil elements. Users must select the appropriate Feature Definition for the discipline and design task being performed. Manual overrides of symbology or element behavior are discouraged, as they may result in non-compliant or inconsistent design output. Proper use of Feature Definitions ensures that design elements adhere to NCDOT standards, remain compatible across disciplines, and behave predictably throughout the project lifecycle.

Feature Definitions are centrally managed by NCDOT within WorkSpace standards libraries (DGNLIB files). Any creation, modification, or removal of Feature Definitions must be coordinated with CSS, CIT, and EDCS. Users must not create custom Feature Definitions unless formally authorized.

Feature Definitions may reference other standards resources such as levels, symbology, cells, or element templates to support consistent behavior and presentation. These supporting resources are governed independently and are addressed in their respective sections of this manual. Feature Definitions serve as the primary user-facing standard that brings these resources together through consistent rules and workflows.

Reference lists for standard NCDOT Feature Definitions and Feature Symbology and their associated symbology are available at the links below. These references are organized by discipline and updated whenever there are changes to the NCDOT WorkSpace to ensure alignment with current standards.

NCDOT Feature Definitions.xlsx

NCDOT Feature Symbology.xlsx

3.9 Levels

Levels define how elements are organized and displayed within CADD files. Symbology settings determine the visual characteristics of elements, such as color, line style, line weight, and fill and hatch properties. NCDOT maintains standardized level libraries and symbology tables within the WorkSpace to support consistent drafting and visualization across disciplines.

Users must only use approved levels from the NCDOT level libraries. Users should not modify level definitions or override global symbology settings. Users should maintain proper level discipline organization for all model content. Correct level usage ensures clarity, predictable display behavior, and compatibility within multi-discipline models.

A complete list of standard NCDOT levels is available at the link below:

NCDOT Levels.xlsx

3.10 Cell Libraries

Cell Libraries contain standardized symbols, details, and recurring design components used across NCDOT projects. These cells ensure consistency in plan presentation and reduce manual drafting effort. Typical contents include standard symbols and markers, detail elements, and discipline-specific drafting components.

Cell Libraries are stored within the OpenX WorkSpace and managed through shared *.cel or *.dgnlib files. Users must select from approved libraries rather than creating custom cells.

3.11 Text

Text styles standardize font, size, spacing, and formatting to ensure legibility and uniformity across all NCDOT plan sheets and design models. The text styles that are automatically applied in civil labels, annotations, plan sheet creation, and any other preset resource should not be modified or changed. These text styles and their settings have been configured to be compliant with NCDOT standards and provide consistent plan sheets when plotted. All text placed in design or sheet files must use approved text styles

provided through the NCDOT WorkSpace. Users must not modify or create custom text styles unless formally authorized.

The available fonts consist of:

- Engr Bold
- Engr Mono
- Engr Mono Bold
- Engr Reg
- Engr Vert
- Engr Vert Bold
- Engr Vert Mono
- Engr Vert Mono Bold
- Highway (B-F)
- Verdana

Future guidance will be issued for text standards that will define approved font use cases, text sizes for model space and paper space, annotation scale requirements, and discipline-specific text rules.

3.12 Dimension Styles

Dimension styles control the formatting and appearance of dimensions, including units and precision, arrowheads and markers, text placement, leader and extension line behavior, and annotation scale compatibility.

Future guidance will be issued that will define standardized dimension styles within the WorkSpace to ensure consistent presentation on all plan sheets.

3.13 Reference Files

Reference files support coordinated plan production by allowing users to view, overlay, and manage design information from multiple disciplines without duplicating data. Proper use of reference files ensures consistency across sheets and reduces file size.

Reference files are used to combine design information from multiple models or disciplines, ensure consistent updates across all sheets when source data changes, and support annotation workflows tied to named boundaries and drawing models. Design data should never be copied, or merged, into another file. The duplication of design data should not occur, and when referencing design files from other disciplines they should never be merged. Using references appropriately prevents data conflicts and improves interdisciplinary coordination.

Level display settings in reference files control visibility and must align with NCDOT standards. Users should only use NCDOT-approved level filters. Do not override global or discipline-specific symbology unless required. Maintain clean level organization to support automated tools such as sheet indexing and batch printing. Proper level control ensures that only required information appears in drawing and sheet models.

To ensure reliable performance and predictable sheet output, users must follow these practices:

- Attach reference files using **coincident-world** when sharing coordinate systems
- Avoid merging references into design files except when explicitly required
- Maintain discipline-specific level and symbology settings as provided in the WorkSpace
- Confirm that all reference paths resolve correctly in ProjectWise or local WorkSpaces
- Ensure that any CADD files uploaded or copied to the NCDOT ProjectWise datasource have reference paths correctly resolved and mapped
- Avoid live-nesting of reference files in design models (plan production workflows use live nesting in drawing/sheet models, which is acceptable)
- Ensure all references are stored within the project's Work Area and avoid cross-project references when working in ProjectWise
- Validate reference integrity before final plan production
- Use ProjectWise's built-in dependency services to track reference relationships
- Do not reference a file into itself. This could break the Civil Elements in that specific file.
- Do not merge civil elements into another file. This could lead to a loss of data.

Maintaining consistent reference structures supports reliable file sharing and model reviews.

3.14 Container Files

A Container File is a designated file that aggregates approved design files of a specific type into one structured reference model. Container files are intended for viewing, coordination, and production use — not for active design.

Container Files are established to maintain consistent reference structures that support reliable file sharing, interdisciplinary coordination, and model reviews. Properly structured container files simplify file access by reducing the number of references required to view complete design information.

Future guidance will be issued on the usage of Container Files during the project delivery process.

To ensure consistency across projects, users must follow these practices:

- Container files shall be created with Live Nesting turned OFF.
- A container file shall directly reference only the approved source files for its designated content type.
- When referencing a container file into another file, Live Nesting shall be set to "1" (Direct References Only).
- Working design files should avoid Live Nesting unless referencing an approved container file.

3.15 Plotting Resources

Plotting resources define the configuration files used to generate PDFs, printed plan sheets, and discipline-specific outputs from OpenX applications. These resources ensure consistent line weights, symbology, colors, and sheet formatting across all NCDOT projects. Each discipline uses a defined set of plotting resources tailored to its plan sheet standards.

NCDOT provided plotting resources include:

- Printer Driver Configuration Files (*.pltcfg)
- Pen Tables (*.tbl)
- Design Scripts (*.pen)

Future guidance will be issued to define the full list of NCDOT plotting resources and establish when they should be used.

Chapter 4 - CADD Modeling

4.1 Overview

CADD modeling within OpenX applications supports the creation, analysis, and review of both 2D and 3D project data. The following terms are important to understand in the context of modeling:

- **Model:** A digital representation of the Project or a subset of the Project. A Model is a collection of one or more Model Portions, each of which is an assemblage of Model Elements.
- **Model Portion:** A subset of a Model often times designated by discipline, area, location, or phase.
- **Model Elements:** A digital representation of a component, system, object, or assembly within a Model.

The term **Model** is often incorrectly used to describe a single 3D roadway design file. Models may exist in either 2D or 3D formats and may encompass multiple files and disciplines. OpenX files may contain multiple internal models (e.g., design or sheet models). These should not be confused with the "Model" terminology defined in this section, which refers to the broader project modeling framework

NCDOT's CADD modeling efforts are guided by the following principles:

- Standardizing 3D modeling and digital deliverables across all disciplines
- Providing data-rich designs to support planning, letting, construction, and maintenance
- Developing guidance and workflows that improve deliverable quality
- Applying clash detection practices to identify spatial conflicts between design elements

NCDOT is moving toward a more standardized approach to model-based project delivery. Over time, NCDOT intends to leverage models to support design authoring and documentation and to establish standards for model-based project delivery.

As these standards are developed, selected projects may be used to pilot various requirements. NCDOT anticipates that model-based project delivery requirements and expectations will continue to evolve as workflows and supporting guidance are further defined.

4.2 Digital Delivery

Digital Delivery is defined as the use and transfer of digital data across preconstruction, construction, asset management, and external stakeholders. The purpose of Digital Delivery is to provide data in a directly consumable format that maximizes the value of information for decision-making and program delivery.

CADD modeling standards support NCDOT's Digital Delivery initiative by improving the quality, consistency, and usability of digital project data across the project lifecycle.

NCDOT is advancing Digital Delivery as a Department-wide initiative to modernize project development and delivery practices. As technology continues to evolve, Digital Delivery supports the transition from traditional, paper-based design and construction processes to the increased use of digital tools, CADD modeling, and data-driven workflows. Improving the consistency, quality, and structure of CADD models is a foundational element of this transition.

Digital Delivery initiatives focus on implementing digital workflows on projects across the Department, while also improving connectivity between systems and applications to enhance the usability and value of project data throughout its lifecycle. As these efforts progress, CADD modeling practices will continue to evolve to better support digital design, coordination, construction, and long-term asset management.

Additional information on NCDOT's Digital Delivery initiative, including guidance and resources, is available on the NCDOT Digital Delivery webpage.

4.3 Level of Development

Level of Development (LOD) defines the degree to which a Model Element has been developed, and the level of confidence contractors may place in the Model at the time it is submitted for Project Let. The NCDOT Level of Development Table communicates design intent by identifying the minimum required LOD for Model Elements and establishes what information may be reliably derived from the Model.

LOD should not be confused with *Level of Detail*. Level of Detail refers to the amount of graphical detail shown, while Level of Development describes how fully the geometry and associated information have been defined and validated.

NCDOT defines minimum LOD requirements for Model Elements associated with pay items in the NCDOT Standard Specifications for Roads and Structures, organized by specification division. Certain Specification Divisions do not include Model Elements and are excluded from the LOD Table. Other elements that don't have corresponding pay items, such as survey, alignment, right-of-way, and easement Model Elements, are also addressed.

Level of Development also serves to communicate the direction NCDOT is moving with respect to model-based project delivery and Digital Delivery initiatives. As modeling practices and workflows continue to mature, the LOD Table will be used to more clearly define modeling expectations when design files are submitted for Project Let. Future guidance will be issued to identify which project types or delivery methods will be required to achieve specified minimum LODs.

This LOD Table is under development and may change. The most current information is available on the NCDOT Digital Delivery webpage.

4.4 Construction Ready Electronic Files

Construction Ready Electronic Files (CREF) are digital deliverables intended for direct use in construction, inspection, and asset management. NCDOT has adopted CADD (.dgn) and LandXML formats as the standard for delivery for Digital Deliverables, including AMG files. LandXML includes basic geometry element types and can be used by many software platforms used in the construction industry. CREFs must be accurate, complete, and compliant with NCDOT Digital Delivery standards.

The latest CREF Workflows outline the required processes for exporting key civil features from OpenRoads Designer, performing quality control checks, and preparing contractor-ready data.

These CREF workflows will evolve as Digital Delivery standards mature. Future guidance will be issued to identify which project types or delivery methods will be required to deliver CREFs at key project milestones.

These are the deliverables that make up NCDOT's CREF package:

4.4.1 Alignments and Profiles

This deliverable includes all existing and proposed horizontal alignments and vertical profiles referenced in design files and plan sheets. It provides the geometric framework of the project and can be used in construction and survey equipment for reference, verification, and coordination with other project elements.

4.4.2 Final Grade Top Surface

The final grade top surface is a triangulated surface developed from proposed modeled elements, capturing all project improvements and modifications. It can be loaded into survey and construction equipment to verify built conditions and is also used for automation of asset management geometry (AMG).

4.4.3 Final Subgrade Surface

The final subgrade surface represents a triangulated model of the roadway at the subgrade level. This deliverable supports verification of subgrade conditions in the field and can be utilized with AMG or other construction equipment to ensure alignment with design specifications.

4.4.4 Existing Top Surface

The existing top surface is a triangulated representation of the current ground conditions, incorporating survey data collected throughout the design process. It provides a reference for design development, verification, and comparison against proposed improvements.

4.4.5 Final Grade Breaklines

Final grade breaklines are 3D line representations generated from the proposed project model that define key surface transitions and edges of design elements. These breaklines can be imported into construction and survey software to guide field implementation and ensure accurate replication of the design.

4.4.6 2D Planimetrics

A 2D planimetric representation of the design is provided for use in construction software and field equipment. This data may be used in conjunction with 3D surface models to support rover and automated machine guidance (AMG) workflows, or independently for integration with GIS and other downstream applications.

4.5 Model Review

The Model Review will assess the accuracy and completeness of 2D and 3D design data to ensure it is reliable and usable across all phases of a project. Reviews will confirm that models conform to NCDOT standards and defined LOD requirements, accurately reflect design intent, and support interdisciplinary coordination.

In addition, model reviews will ensure that design data is suitable for downstream applications, including plan production, analysis, construction, and asset management. NCDOT will conduct these reviews using Bentley Infrastructure Cloud to provide centralized access, version control, and collaborative review capabilities. Detailed guidance on formal review workflows, including responsibilities and procedures, will be issued in the future as part of NCDOT's ongoing Digital Delivery initiative.

Chapter 5 - CADD Production

5.1 Creating Sheets

Creating sheets in OpenX involves creating, organizing, and managing sheet models that compose the project's plan set. Sheet production relies on drawing models, named boundaries, annotation settings, and NCDOT's standardized WorkSpace resources.

It is important that plan sheets are created consistently across disciplines and conform to NCDOT production requirements.

5.1.1 Drawing Models

Drawing models contain the specific plan, profile, or cross-section views used to create the corresponding sheets. They are generated from 2D or 3D design files, include appropriate annotation, labels, and dimensions, and are configured with the required drawing scale. Drawing models isolate the design content needed for sheet creation without altering the design file itself.

5.1.2 Sheet Models

Sheet models represent the printed output for individual sheets. They include title blocks, sheet borders, project metadata, and layout settings, reference drawing models created earlier, and support single or multi-view layouts depending on sheet type. Each sheet model corresponds to one sheet in the final plan set.

5.1.3 Named Boundaries

Named Boundaries define the extents of plan, profile, or cross-section views and drive automated sheet creation. They enable consistent sheet extents, automated generation of sheets, and standardization in view settings that carry over into drawing models.

Projects must use NCDOT-standard named boundary creation tools and settings to ensure alignment with sheet templates and sheet indexing.

5.1.4 Annotation and Scaling

OpenX applies annotation based on the drawing scale defined in the drawing model. Users must ensure that the correct annotation scale is applied in the design model; and the correct detail scale is applied in the sheet model. Text, leaders, dimensions, and symbols must use NCDOT-approved annotation styles. Annotation scale errors can cause inconsistent output and must be corrected before final sheet creation.

5.1.5 Sheet Indexing

OpenX's Sheet Index organizes all sheets in a hierarchical structure to support project-level sheet organization, automated numbering, batch printing, and cross-referencing. Sheets must be added to the index and sequenced correctly.

5.2 Sheet Numbering

Sheet numbering provides a standardized method for identifying, organizing, and referencing sheets within an NCDOT plan set. Consistent numbering ensures clarity across disciplines and supports automated workflows such as sheet indexing, review processes, and plan set printing.

Plan Numbering is currently defined in each Discipline's Design Manual. Future editions of this CADD Manual will include a comprehensive list of plan numbers.

5.3 OpenX Printing

OpenX applications provide multiple tools for generating printed and digital plan sets. Proper printing relies on applying the correct plotting resources, sheet models, named boundaries, and discipline-specific pen tables as defined in Section 3.13.

Users may print individual sheets using the Print dialog or generate full plan sets using the Print Organizer. All printing must apply NCDOT-approved plotting configurations to ensure consistent output across disciplines. If plotting sheets which include a raster image, then ensure the following plot settings are enabled:

- Rasterized Mode: must be enabled in the print dialog to correctly plot transparency and raster line styles
- Raster Quality Factor: Located in the Raster Options Dialog, this sets the percentage of printer DPI used from 0% to 100%; i.e. 50% qualify factor for a raster with 600 DPI will plot at 300 DPI. This value can be modified if the PDF plot is too large and a detailed aerial image is not necessary.
- Default Raster Quality Factor to start: 50% (Note: Leave Rasterized Quality Factor at 100%)
- Driver Resolution / Dots per Inch (DPI): The resolution of pixels per unit (inch) which can be modified to provide higher resolution.
- Default Driver Resolution / Dots per Inch (DPI): 600
- Contrast & Brightness: Can be used to "shade back" aerial imagery in the Raster Manager.
- Default Contrast & Brightness: -50% Contrast, +50% Brightness (provides shaded back aerial backgrounds)
- Note: If aerial maps are being used, it is recommended to attach them through the Raster Manager as this allows a greater level of control over the look and quality and allows for easier plotting of sheets with the aerial images.

5.3.1 Single Sheet Printing

Single sheets can be printed directly from the OpenX Print dialog. This method applies WorkSpace-configured pen table, discipline-specific plotting resources, and sheet model properties (scale, borders, annotation).

5.3.2 Batch Printing with Print Organizer

The Print Organizer automates the creation of multi-sheet PDF plan sets using predefined print styles and configuration files. Print styles control printer configuration, paper size, pen tables, and other production settings. Users must ensure the correct print style is applied before generating plan sets.

Chapter 6 - CADD Delivery

This chapter will define how PDFs and CADD files should be submitted and shared throughout the project lifecycle using ProjectWise, SharePoint, and ATLAS. Specific delivery requirements—including file types, PDF naming conventions, and submission procedures—will be established in a future release of the NCDOT CADD Manual. These requirements will ensure consistent, accurate, and verifiable delivery of design data across all projects while supporting efficient review, coordination, and downstream use.

The CADD Delivery framework will include guidance for key aspects of project file management, including:

- PDF file naming conventions and organization
- Submission of PDFs and design files for internal design submittals
- Submission of PDFs and design files for Project Let
- Handoff and acceptance procedures for submittals
- How files transition between Preconstruction and Construction Sites

By standardizing these processes, NCDOT intends to streamline project delivery, reduce errors, and improve accessibility and usability of digital project data for all stakeholders. Detailed instructions and requirements for each of these areas will be provided in an upcoming update to the CADD Manual.

Appendix A. Reference Materials

This appendix provides a list of reference materials and resources that informed the development of this manual. These materials are provided for informational purposes and are not directly cited in the text.

Florida Department of Transportation CADD Manual

Texas Department of Transportation Model Development Standards Guidance

Utah Department of Transportation CADD Standards Manual