

GUIDELINES FOR ELECTRONIC ENGINEERING DATA (EED) DELIVERY

The Connecticut Department of Transportation (CTDOT)

Contents

GUIDELINES FOR ELECTRONIC ENGINEERING DATA (EED) DELIVERY	1-1
Section 1 Introduction	1-2
1.1 Purpose	1-2
1.2 Definition of EED	1-2
1.3 Coordination of Document and Data Conflicts	1-2
1.1 Implementation Phases	1-3
Section 2 Phase 1 & 2	2-7
2.1 Overview of Phase 1.....	2-7
2.2 Overview of Phase 2.....	2-13
2.3 Quality Review	2-16
2.4 Submission Procedures	2-17
Section 3 Phase 3	3-22
3.1 Overview Phase 3.....	3-22
3.2 Quality Review	3-22
3.3 Submission Procedures	3-22
Appendix A Electronic Data Definitions.....	3-26
Appendix B Benefits	3-28

Section 1 Introduction

1.1 Purpose

This guide has been prepared to give direction to project design personnel associated with the Connecticut Department of Transportation (CTDOT) in accordance with [The Directive for Electronic Engineering Data Delivery](#). The intent of this document is to provide standards and guidelines to promote consistent, uniform, and useable deliverables for CTDOT construction projects. It is not the intent of this guide to add unnecessary additional responsibilities to the designer, but rather to have the projects delivered in a consistent manner following best practices and industry standards used in the today's CAD environment.

1.2 Definition of EED

Electronic Engineering Data (EED) refers to the Computer Aided Design (CAD) files and the Digital Civil Engineering data files were used to create the pdf contact plans. These files include:

- 2D and 3D geospatially located CAD files
 - MicroStation (DGN) Design Models
- InRoads Data
 - Coordinate geometry - Horizontal and Vertical alignments (ALG) files
 - Roadway Surfaces - InRoads digital terrain models (DTM) files
- OpenRoads Infrastructure Consensus Models (ICM) & i-models
 - Coordinate geometry
 - Digital Terrain Models
 - Storm Drainage, Structure and Pipe Data – Subsurface Utility Engineering (SUE)

1.3 Coordination of Document and Data Conflicts

Section 1.05.04 of the Standard Specifications for Roads, Bridges and Incidental Construction shall be modified to include EED data. The following order of governance in order of descending authority shall be as follows:

1. Environmental Permits
2. Environmental Permit Applications
3. Special Provisions
4. Plans other than Standard Sheets (enlarged details on plans, used to clarify construction, shall take precedence over smaller details of the same area; and information contained in schedules or tables, titled as such, shall take precedence over other data on plans)
5. Standard Sheets
6. Supplemental Specifications
7. Standard Specifications and other Contract requirements
8. Electronic Engineering Data as defined by the latest edition of CTDOT's "GUIDELINES FOR ELECTRONIC ENGINEERING DATA (EED) DELIVERY".

1.1 Implementation Phases

The requirements for EED will be implemented in three phases. A phase structure was developed to ease the Department into the **3D MODELING WORLD**. This guide has been broken out to detail the files submittal types for all phases. Tables 1 and 2 outline Data Requirements based on the Project type for each phase of implementation.

- **Phase 1** will focus on the practice of submitting clean CAD and Geometry files. These projects are designed in-house on the internal network or by consultants on an external network. All projects designed using InRoads SS2 will follow the data requirement in [Section 2.1](#). All work will be completed externally from ProjectWise and imported in as described in [Section 2.4](#).
- **Phase 2** will add the submission of curb to curb roadway surfaces using the department current modeling software InRoads SS2. These projects are designed in-house on the internal network or by consultants on an external network. All projects designed using InRoads SS2 will follow the data requirement in [Section 2.2](#). 3D designs in this phase will only require (at minimum) the 3D models to be complete from curb to curb for the entire project. All work will be completed externally from ProjectWise and imported in as described in [Section 2.4](#).
- **Phase 3** will change the data delivery files type using OpenRoads technology (InRoads SS4 and beyond). In the upcoming years all new roadway projects designed at CTDOT will require the use of OpenRoads Technology. All projects designed using this technology will follow the data requirement in [Section 3](#). For these future projects 3D models will include all work out to the grading limits for the entire project. All work will be completed in ProjectWise and linked to using Sets as described in [Section 3.4](#).

1.1.1 Why and When should a 3D Model be Developed?

Nationally the civil industry is quickly recognizing business improvements and lower costs by changing field operations to incorporate the use of EED. One of these practices is the utilization of 3D modeling for the development of model based digital design data.

The concept of model centric design, and the generation of digital design data for use in construction, involves the following key steps:

1. Collection and development of geospatially located survey data for an accurate existing conditions model to be used for design, and also to be delivered for use in bidding on the project.
2. Utilization of the survey model in design, with design software capable of 3D model output.
3. Proposed output from design of critical digital deliverables for use in bidding, construction and inspection purposes on the project.
4. Utilization of digital deliverables in constructing the project in an automated fashion.
5. Field collection of as-constructed and inspection measurements and observations using modern positioning technology, relative to the engineered model data.
6. Archiving and preservation of digital model data for future use, including asset management.

Connecticut Department of Transportation Specifications Electronic Engineering Data (EED) Delivery
FHWA has promoted the adoption of this technology through their Every Day Counts 2 and 3 initiatives. According to FHWA, “Three-dimensional (3D) modeling in transportation construction is a mature technology that serves as the building block for the modern-day digital jobsite. The technology allows for faster, more accurate and more efficient planning and construction.”*

For more information on please visit the U.S. Department of Transportation, Federal Highway Administration, EDC2 Website titled 3D Engineered Models website at:

<http://www.fhwa.dot.gov/construction/3d/about.cfm>

Digital 3D models of a highway project can convey a greater level of design intent than a 2D model; therefore, design projects should be developed in 3D when it is practical to do so. The following are guidelines to help determine projects in which 3D models may be beneficial.

- Cross sections will be included in the final plan set.
- Reconstruction is proposed within the project limits. If the reconstruction is only a component of the overall project (e.g., mill and overlay scope of work with a section of reconstruction) only the reconstruction area should be designed in 3D unless an accurate surface was obtained of the entire project.
- Major roadway rehabilitation (structural enhancements that both extend the service life of an existing pavement and/or improve its load-carrying capability).
- Complex storm water and drainage in order to check for clearances under roadway subbase and clash detection (i.e. utility conflicts).
- Intersections
- Subsurface utility information that is located.

1.1.2 Data Requirements for Each Phase

Type 1 – No Earth Work 2D Projects	Type 2 – Site Earth Work 3D Site Projects
Bridge Deck/Superstructure Replacement	Bicycle/Pedestrian Facility (Multiuse Trails)
Bridge Restoration/Rehabilitation	Bridge Replacement W/Realignment Of Approaches
Bridge Substructure/Superstructure Repairs	Drainage - Major
Concrete Barrier Rail	Facility Construction (Site Work)
Drainage - Minor	Hazardous Waste Removal
Facility Rehabilitation	Retaining Walls/Slope Stabilization
Fixed Objects Modification	Wetland Replacement/Restoration
Grade Crossing - Minor Improvement	
Guiderail Improvements	
Illumination	
Intelligent Trans Systems	
Landscaping	
Maintenance	
Noise Barriers	
Resurfacing By Contract	
Roadside Safety Improvements	
Traffic - Paint & Epoxy Pavement Markings	
Traffic - Signal Installation	
Traffic - Signal System Improvement	
Traffic - Signing	
Transit	
Utility Projects	

Type 3 – Roadway Earth Work 3D Roadway Projects
Intersection Improvement - Minor
Intersection Realignment
New Interchange
Operational Lane
Realignment
Widening - Major (4r Projects)
Widening (3r Projects) - Minor

Table 1 Project Types

		Type 1			Type 2			Type 3		
		No Earth Work			Site Earth Work			Roadway Earth Work		
		Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
CAD Files	Proposed MicroStation File	R	R	R	R	R	R	R	R	R
	Existing Ground MicroStation File	D	D	D	D	D	D	R	R	R
InRoads Files	Geometry ALG File	D	D		D	D	D	R	R	
	Top Surface Curb to Curb DTM File					D			R	
	Substructure Surface DTM File					D			D	
	Existing Surface DTM File					D			R	
OpenRoads Files	Geometry Data			D			D			R
	Top Surface Data Terrain						R			R
	Subsurface Data Terrain						R			R
	OpenRoads Terrain						R			R
	Existing Surface Data Terrain						D			R
	Storm Drainage Data SUE						D			R

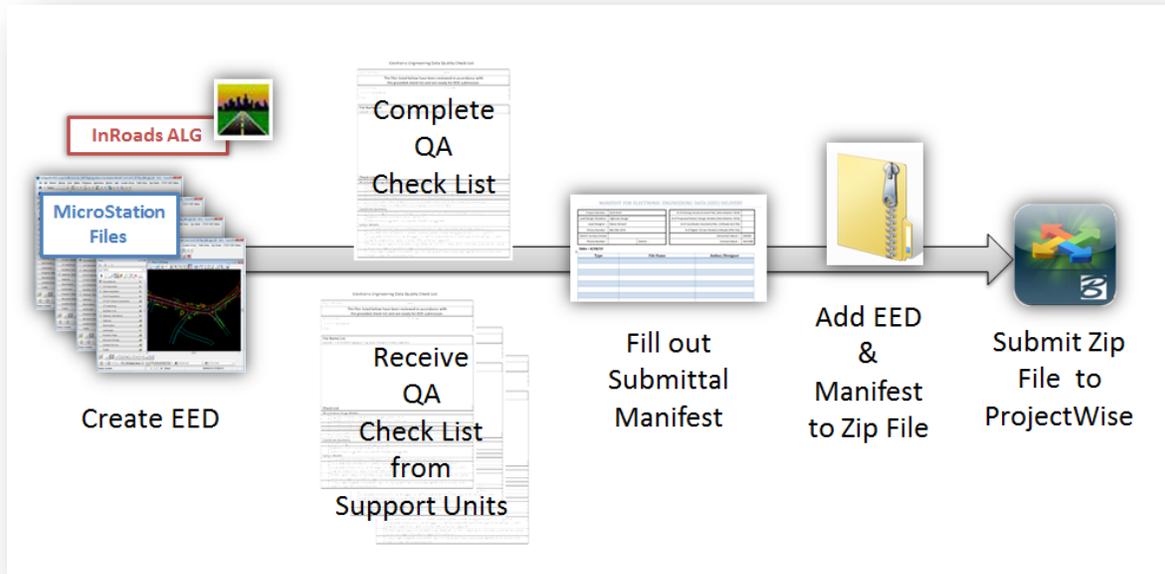
R = Required

D = Discretionary (Required if used during design)

[Table 2 Data Requirements for each Phase of Implementation](#)

Section 2 Phase 1 & 2

2.1 Overview of Phase 1



2.1.1 Existing Survey Ground File(s) (.dgn)

CTDOT uses Bentley software products for all their computer aided design needs, with MicroStation (.dgn format) being the foundation to all computer modeling. Therefore it is critical that MicroStation EED files be submitted to the CTDOT and conforms to the following criteria:

- All elements shall be placed using CTDOT's customized MicroStation Task Manager or be generated by InRoads Survey Tools. This will ensure that all CAD graphics have the correct attributes (color, weight, line style, level).
- Must be compatible with CTDOT's current [SELECTSeries DDE](#).
- Elements must be placed in real world modified state plane coordinates and be geospatially correct
- Only one design model per dgn file; no drawing or sheet models are to be used

All elements representing existing topography features shall be drawn according to the current CTDOT Survey standards; [Location Manual and Digital Mapping and Symbols Specification](#). These MicroStation file(s) shall contain a single 3D design model including both 3D and 2D elements of the existing survey. 2D elements included but are not limited to ROW lines and control lines. 3D element includes tangible elements such as edges of pavement, shoulders, curbs, gutters, sidewalks and retaining walls.

2.1.2 Proposed Master Design Files (.dgn)

CTDOT uses Bentley software products for all their computer aided design needs, with MicroStation (.dgn format) being the foundation to all computer modeling. Therefore it is critical that MicroStation EED files be submitted to the CTDOT and conforms to the following criteria:

- All elements shall be placed using CTDOT's customized MicroStation Task Manager or be generated by InRoads using the CTDOT preference files. This will ensure that all CAD graphics have the correct attributes (color, weight, line style, level) and follow CTDOT's CAD standards.
- Must be compatible with CTDOT's current [SELECTSeries DDE](#).
- Elements must be placed in real world modified state plane coordinates and be geospatially correct
- Any 2D files generated from a 3D file must be in direct correlation to the 3D parent file.
- Only one design model per dgn file; no drawing or sheet models are to be used

A separate master design file which includes either a 2D design model, 3D design model or both shall be created and submitted to the CTDOT, by either the state or consultant designers for each discipline per site. Content of the models will vary depending on the discipline and site. The Office of Contracts shall then make these models available to the appropriate contractor(s) for information only.

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A. Proposed Master Highway Models

This 2D Design Model DGN will include geometric line work such as centerlines, and proposed right of way lines. This file will also include right of way dimensions, roadway dimensions and centerline annotation. All features that are to be quantified shall be included in this file (i.e. guide rail, fences, etc.).

Level of Detail
Patterned Riprap Channels
Patterned Riprap Slopes
Patterned Pavement Removal
Patterned Milling
Erosion control Matting for Channels
Erosion control Matting for Slopes
Processed Aggregate
Pavement for Railing
Sodding
Turf Establishment

Table 3 – LOD Proposed Master Highway Models for 2D Shapes

Level of Detail
Sedimentation Control Fences
Cut limit
Fill limit
Fence
Front face of landscape wall
Single PCBC
Double PCPC
Temporary PCBC
Cut Pavement
Parking lot
Driveway
ROW – graphical representation of an InRoads alignment.
Centerline and Baseline – graphical representation of an InRoads alignment.
Guide Rail –The end anchor should be placed in the correct location. The smart line is to be offset from EOR so it can be graphically seen (Connecticut Standard Details for placement will supersede plan placement).

Table 4 – LOD Proposed Master Highway Model for 2D Smartlines

B. Proposed Master Storm Drainage Models

The Storm Drainage Model DGN file will be either 3D using InRoads Storm and Sanitary or 2D using StormCAD. The master Storm Drainage Models shall include but not be limited to the following:

Level of Detail
Pipes – Double line representing the inside Diameter at invert elevations
Culvert ends – 2D cell placed at invert elevations
Endwalls, Riprap Splash Pads and Scour Holes – 2D shape at invert elevation
Catch Basins – 2D cell placed at top of grate elevation
Paved Apron– 2D shape at grate elevation
Manhole – 2D cell placed at top of frame elevation

Table 5 - LOD Storm Drainage using Storm and Sanitary

Level of Detail
Pipes – Double line representing the inside Diameter at elevation 0
Culvert ends – 2D cell placed at elevation 0
Endwalls, Riprap Splash Pads and Scour Holes – 2D shape at elevation 0
Catch Basins & Structures – 2D cell placed at elevation 0
Paved Apron– 2D shape at elevation 0
Manhole – 2D cell placed at top of elevation 0

Table 6 - LOD Storm Drainage using StormCAD

C. Proposed Master Structure/Bridge Models

The lead structural designer shall submit to the CTDOT a single 3D design model, per site and project, in a single 3D DGN file for every project that contains a new footing (including new box culverts). Each 3D design model shall include all components associated to the particular site and project.

The single 3D DGN file and its corresponding model shall conform to the following formats and include the following components:

- All components must be referenced into a single model
- Elements shall be placed using CTDOT’s customized MicroStation Task Manager.
- Components modeled in MicroStation shall be Feature Model Elements.
- All elements shall be geospatially correct.
- All elements shall be placed at 1:1 scale.

The master structural model shall include but not be limited to the following components:

Level of Detail
Wall and Abutment Footings.
Pier footings, stems and caps
Wall and Abutment Stems.
Piles
Parapets
Bridge Deck
Cheek Walls
Back-walls
Approach Slabs
Reinforcing Steel
Sheet Piling (temporary and permanent)
Utilities affecting project

Table 7 - LOD Structure Elements

Level Of Detail
Bituminous pavement
Reinforced concrete deck
Parapets and sidewalks

Table 8 - LOD Roadway over Structure

Level of Detail
Structure excavation earth and rock
Pervious structure back fill
Granular fill

Table 9 - LOD Structure Elements Earth

D. Proposed Master Landscape Models

The master landscape model shall include a single DGN file with one 2D design model per file, per location, per project. All features that are to be quantified shall be included in this model.

E. Proposed Master Traffic Models

The master traffic model shall include one 2D design model per site. This model shall include all items that are to be quantified.

F. Proposed Master Miscellaneous Models

These models could be but not limited to staging plans and or other disciplines not listed above that have items to quantify.

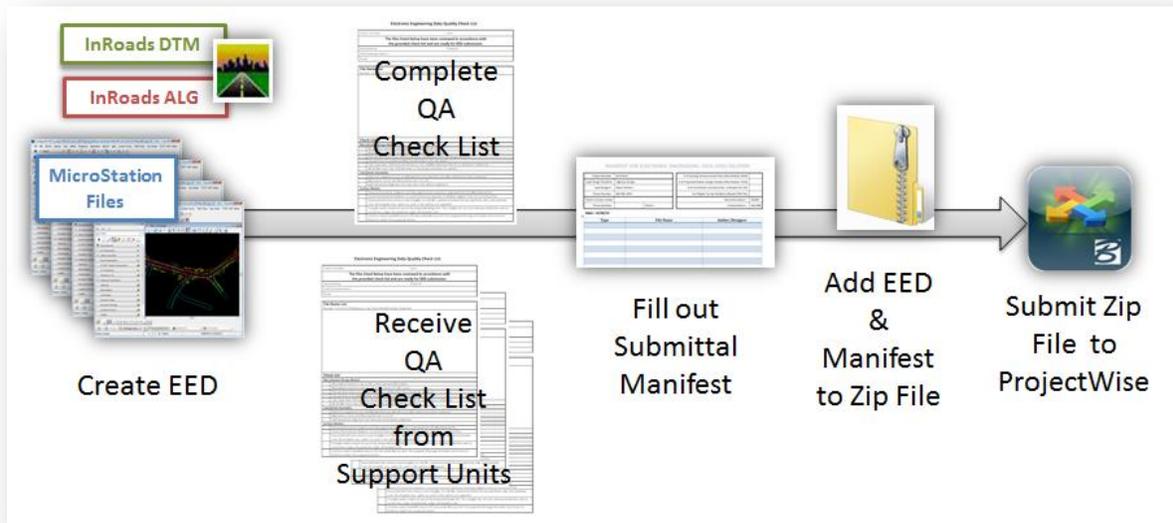
2.1.3 Coordinate Geometry Files (.ALG)

A single (.alg) InRoads file shall be submitted per discipline. Only final alignments are required (do not include preliminary or alternates information). The .ALG files shall include all centerline and baseline horizontal and a maximum of one vertical geometry per horizontal (including structures). All geometry contained in these file shall have names representative of the designed alignments and features found in the plans (Centerline = Route_84_ Eastbound). All coordinate geometry information must be provided in the native InRoads (*.alg) format. Engineering discretion shall be used in determining which geometry elements shall be displayed in the master highway model. Alignments shall follow the specifications outlined in [CTDOT's Location Survey Manual, June 1997](#).

Level of Detail
Horizontal alignments for all roadway centerlines/baselines
Type 2 Projects only - Vertical alignments for all roadway centerlines/baselines
Horizontal alignments for all proposed ROW
Special alignments used for drainage purposes and skewed driveways
Alignments used for design features such as edge of roads, sidewalks & retaining walls
Structure centerlines of bearings
Structure centerlines of girders

Table 10 – LOD ALG File

2.2 Overview of Phase 2



2.2.1 Existing Survey Ground File(s) (.dgn)

[See Section 2.1.1](#)

2.2.2 Proposed Master Design Files (.dgn)

[See Section 2.1.2](#)

2.2.3 Coordinate Geometry Files (.ALG)

[See Section 2.1.3](#)

2.2.4 Digital Terrain Models (DTM)

A Digital Terrain Model (DTM) is a three-dimensional topographic model which mathematically and graphically represents the existing and proposed surfaces. It consists of a triangulated surface with features. A feature is a named set of points in a Digital Terrain Model (DTM). There are five feature types which define the structure of the feature and controls how it affects the triangulated model. Each of these feature types has a feature style or styles, which controls how they are displayed.

- Random - “spot” points which have no direct relationship with other points
- Breakline - groups of points with a direct linear relationship
- Exterior - Surface boundary extent; closed and only one per surface
- Interior - defines undefined areas; closed and no limit to number
- Contour - groups of points with a direct linear relationship and same elevation

Any DTM used to generate final contract plans must be submitted. For Phase 1 Type 2 projects this will include all surfaces curb to curb for the entire project. These projects would also be the type which in most situations will require the inclusion of Item 9.80 Construction Staking. Files must meet the following criteria to be submitted with the EDD for CTDOT projects:

- InRoads uses DTM data to produce contours, display the existing and proposed ground lines in profile and cross section grids, and in the calculation of cut and fill quantities. Supplied surface files must be in the native InRoads .dtm format.
- Project model deliverables shall include at a minimum, two proposed DTMs and an existing DTM. One proposed surface shall be a finished grade DTM, and the other shall be a top of subgrade DTM. It is important to note that the subgrade data is available with the top surface DTM but when the top surface gets exported using LAND XML for use with AMG technology the subgrade data gets automatically dropped. For this reason a separate subgrade surface needs to be delivered.

Level of Detail
3D design has no overlaps of breaklines or visual inconsistencies of features.
Surface features are continuous over their entire length, not broken into multiple pieces.
2D contract plans match the surface models.
No vertical faces are present (all vertical surfaces are to be offset a minimum of 1/12 in – 1/8 in to be accepted into the AMG software).
Accuracy clash detection, spot check x, y and z coordinates.

Table 11 - LOD DTM FILES

DTM Types

A. Existing

Existing Digital Terrain Models represent existing ground conditions at the time that surveying data was collected. This original ground DTM represents the undisturbed ground surface prior to construction. There may be several existing DTM’s depending on the length of the project and the number of project site locations.

B. Design

Proposed Digital Terrain Models represent the project design as generated by InRoads using the horizontal alignments, vertical alignments, templates, roadway definitions and surfaced editing tools.

A top surface for each corridor will need to be created representing at minimum the proposed finished grade **curb to curb** as part of the design data deliverables. All proposed DTM surfaces shall be defined by a breakline density interval (frequency of cutting templates) of no more than five feet, and at every event location. In tightly constrained or critical drainage areas, or on the outside of sharp horizontal curves, the break line interval may need to be reduced to two feet or less.

C. *Substratum*

All files created to represent the approximate Substratum surfaces will also need to be supplied. Substratum surfaces are used to represent assumed existing subsurface layers, such as rock, sand, clay etc.

D. *Subgrade (Structure)*

If underground structures are involved multiple subgrade surfaces will need to be generated to include all bottoms of footings, granular fill, box culverts, piers, walls, abutments, sign supports and bottom of excavation.

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2.3 Quality Review

Each design unit submitting files to the EED will need to have their files reviewed by AEC Applications at the semi-final design review. Each unit will need to fill out the **Phase 1 & 2 Electronic Engineering Data Quantity Check list** and submit it to AEC Applications. The files will be reviewed and needed corrections will be noted. Files should be correctly named as shown in the table below.

Type	Convention	Examples
MicroStation Files		
Existing Survey Ground DGN	SV_D#_Project_Number_Description.dgn	SV_D1_1234_1234_GRN-01.dgn
Proposed Master Design DGN 2D Plan View Design Models	Discipline_MST_Project_Number_2D-Design.dgn	HW_MST_1234_1234_2D-Design.dgn SB_MST_1234_1234_2D-Design.dgn TR_MST_1234_1234_2D-Design.dgn
Proposed Master Design DGN 3D MicroStation Design Models	Discipline_MST_Project_Number_3D-Design.dgn	HW_MST_1234_1234_3D-Design.dgn SB_MST_1234_1234_3D-Design.dgn
Proposed Master Design DGN Drainage Models	Discipline_MST_Project_Number_2D-Drainage.dgn Discipline_MST_Project_Number_3D-Drainage.dgn	HW_MST_1234_1234_2D-Drainage.dgn HW_MST_1234_1234_3D-Drainage.dgn
InRoads Coordinate Geometry		
Proposed Geometry ALG	Discipline_Project_Number.alg	HW_1234_1234.alg BR_1234_1234.alg
InRoads Digital Terrain Models		
Existing DTMs	SV_D#_Project_Number_OptionalDescription.dtm	SV_D1_1234_1234.dtm
Proposed Finished Grade DTM	Finished_Grade.dtm	Finished_Grade.dtm
Substratum DTMs	Substratum_MaterialType_#.dtm	Substratum_Rock_1.dtm Substratum_Rock_2.dtm Substratum_Unsuitable_1.dtm
Roadway Subgrade DTMs	Subgrade_RoadwayName.dtm	Subgrade_Rte123.dtm Subgrade_CedarStreet.dtm
Structure Subgrade DTMs	Subgrade_StructureType_Location.dtm	Subgrade_Footing_BridgeNo1234-NE.dtm Subgrade_BoxCulvert_Sta12-00LT

Figure 2-1 File Naming Conventions

2.4 Submission Procedures

All required EED documents shall be submitted for the following submissions:

- At FDP
- At award of Contract (includes all addenda)
- After design initiated change orders, that the lead design deems necessary to supply to the contractor.

2.4.1 Zip File

Each support discipline designer shall forward links to their documents to the lead designer. All design work will be completed outside of ProjectWise > added to a Zip file > imported into the corresponding ProjectWise project folder 100_Contact_Plans. The lead designer shall submit all documents in a zipped folder into the 130_Final_Engineering_Reports_and_FIO Documents folder in ProjectWise in accordance with the following section 2.3.

2.4.2 EED Delivery Manifest

The EED delivery manifest must be filled out by the lead designer and added to the Zip file along with the EED data. A blank copy can be found by clicking on the following link: [EED Delivery Manifest](#). This form will include general project information; the datum used for the ground survey; file names and specific information about each EED file being submitted. The contact information for the lead designer and lead surveyor must also be provided.

2.4.3 Uploading Zip file to ProjectWise

2.4.3.1 ProjectWise Thin (web based) Client

Once logged into ProjectWise, the EED documents shall be submitted as follows:

1. Make sure the CTDOT_Doc_Code interface is selected as shown below:

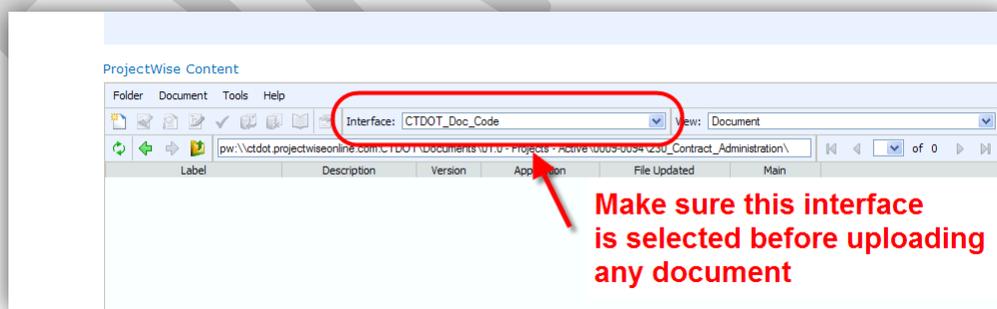
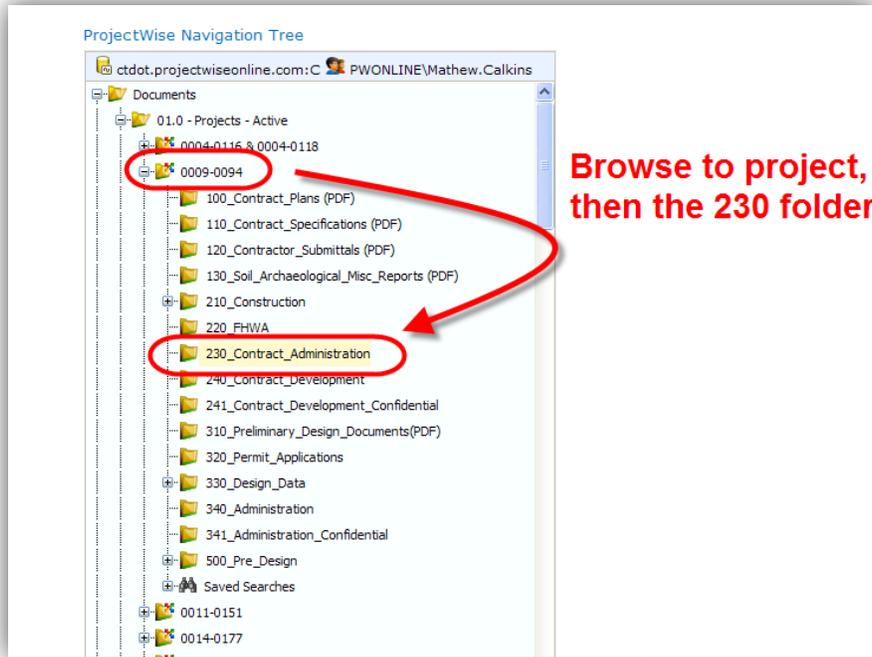


Figure 2-2 - Selecting Interface

Note: If the Interface dialog is not showing, go to View>Toolbar and select Interface

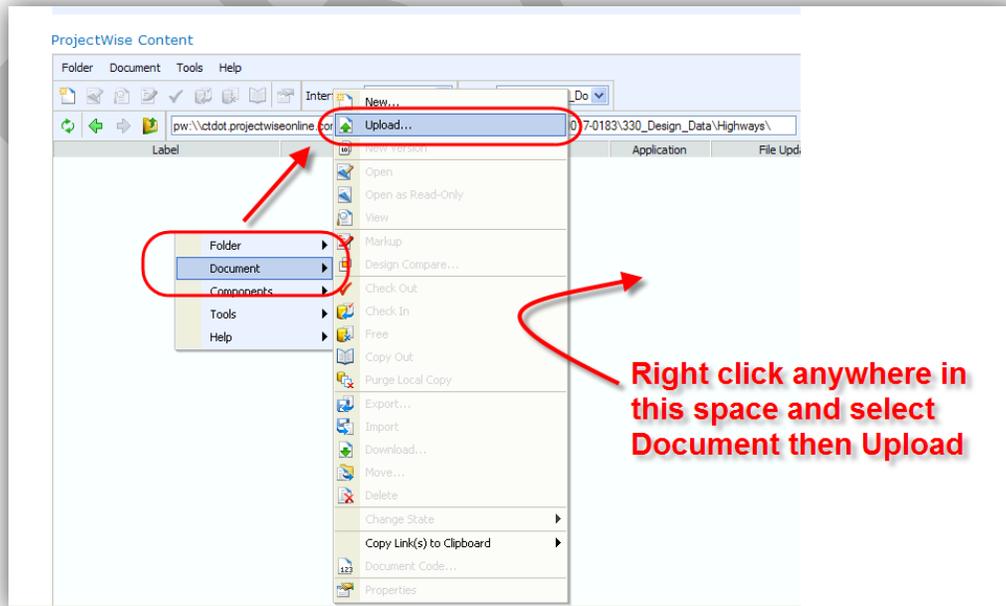
- Next browse out to your project, then to the 230_Contract_Administration folder, as shown below:



Browse to project, then the 230 folder

Figure 2-3 - Browse to Project Folder

- Next right click in the area to the right and select *Document* then *Upload*.



Right click anywhere in this space and select Document then Upload

Figure 2-4 - Uploading a Document

4. Browse out to the folder on your computer where the documents are and select a document.

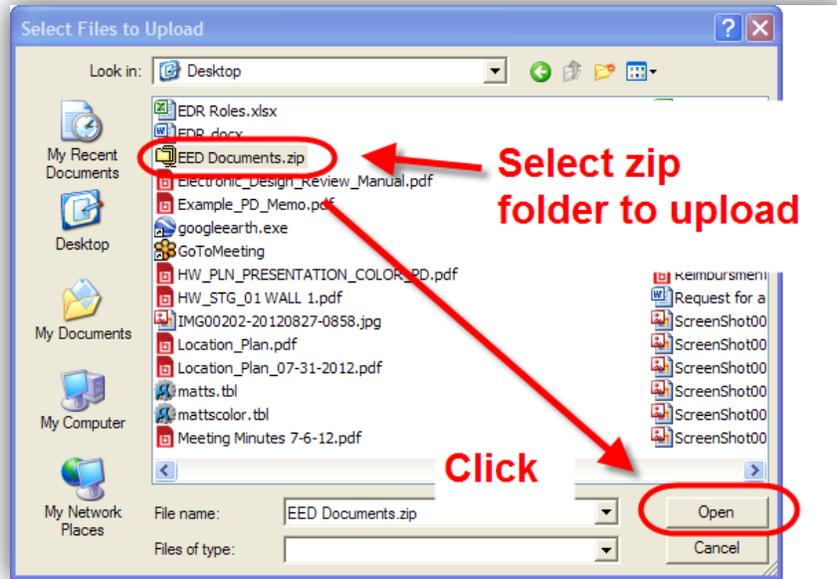


Figure 2-5 - Uploading the Zipped Folder

5. The file will upload into ProjectWise.
6. Once the document has been uploaded it needs to be attributed as shown in the following figures below:

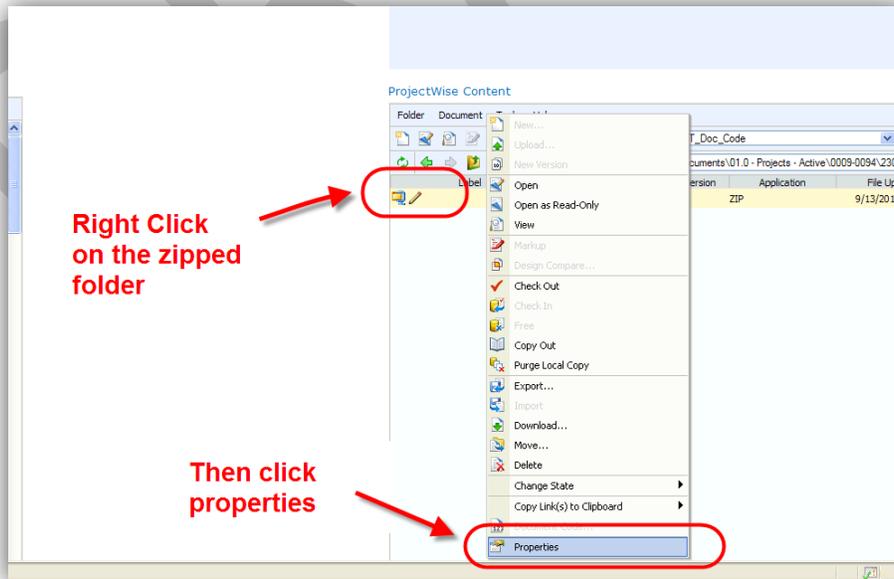


Figure 2-6 – Attributing

In the window that pops open adjust the attributes as shown below. In the label include which submission this is for, FDP, addendums or change Orders.

Discipline = **CT**

Main Category = **CON**

Sub Category = **EED**

Label

Final design Plans = **FDP**

Addendums = **ADDENUM-1**

Construction Change Orders = **CO-1**

2.4.3.2 ProjectWise Thick Client

Each support discipline designer shall forward links to their documents to the lead designer. The lead designer shall submit all documents in a zipped folder into the 230_Contract_Administration folder in ProjectWise in accordance with the following.

Once logged into Projectwise, the EED documents shall be submitted as follows:

1. Make sure the CTDOT_Doc_Code interface is selected as shown below:

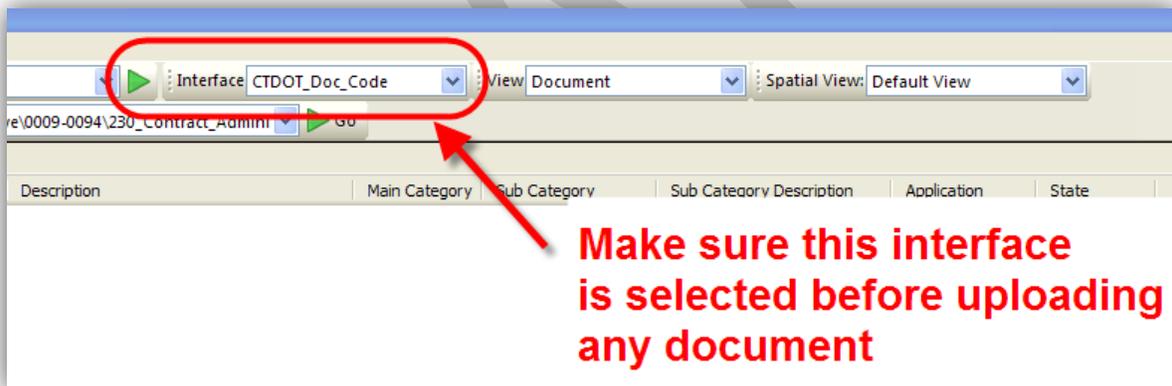


Figure 2-7 – Interface

2. Browse out to the project folder and click on the 230 folder

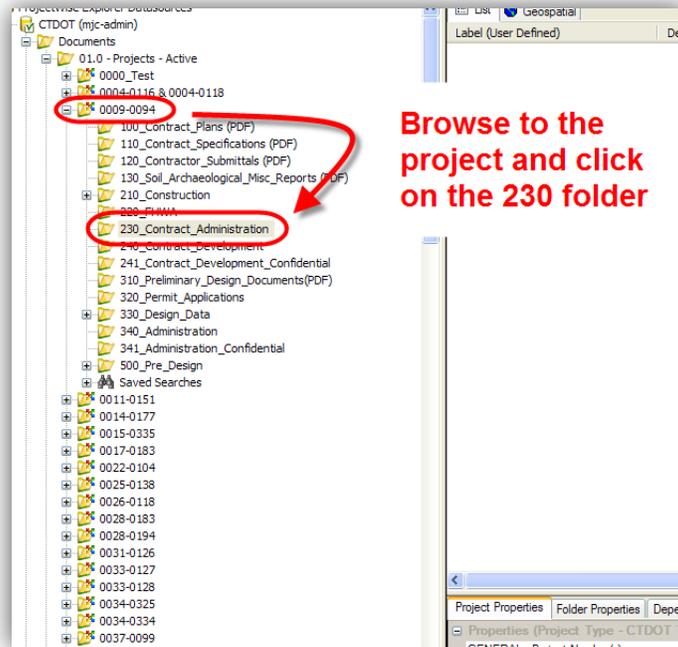


Figure 2-8 - Browse to the 230 folder

3. Drag and drop your document into the area on the right and choose the advanced wizard.



Figure 2-9 - Advanced Wizard

4. Click Next until you get to the attributes screen shown below. In the label include which submission this is for, FDP, addendums or change Orders.

Discipline = **CT**

Main Category = **CON**

Sub Category = **EED**

Label

Final design Plans = **FDP**

Addendums = **ADDENUM-1**

Construction Change Orders = **CO-1**

Section 3 Phase 3

3.1 Overview Phase 3

Details coming soon

3.1.1 Existing Survey Ground File

Details coming soon

3.1.2 Proposed Master Design Files

Details coming soon

3.1.3 Coordinate Geometry Files

Details coming soon

3.1.4 Integrated Civil Models

Details coming soon

3.2 Quality Review

Details Coming Soon

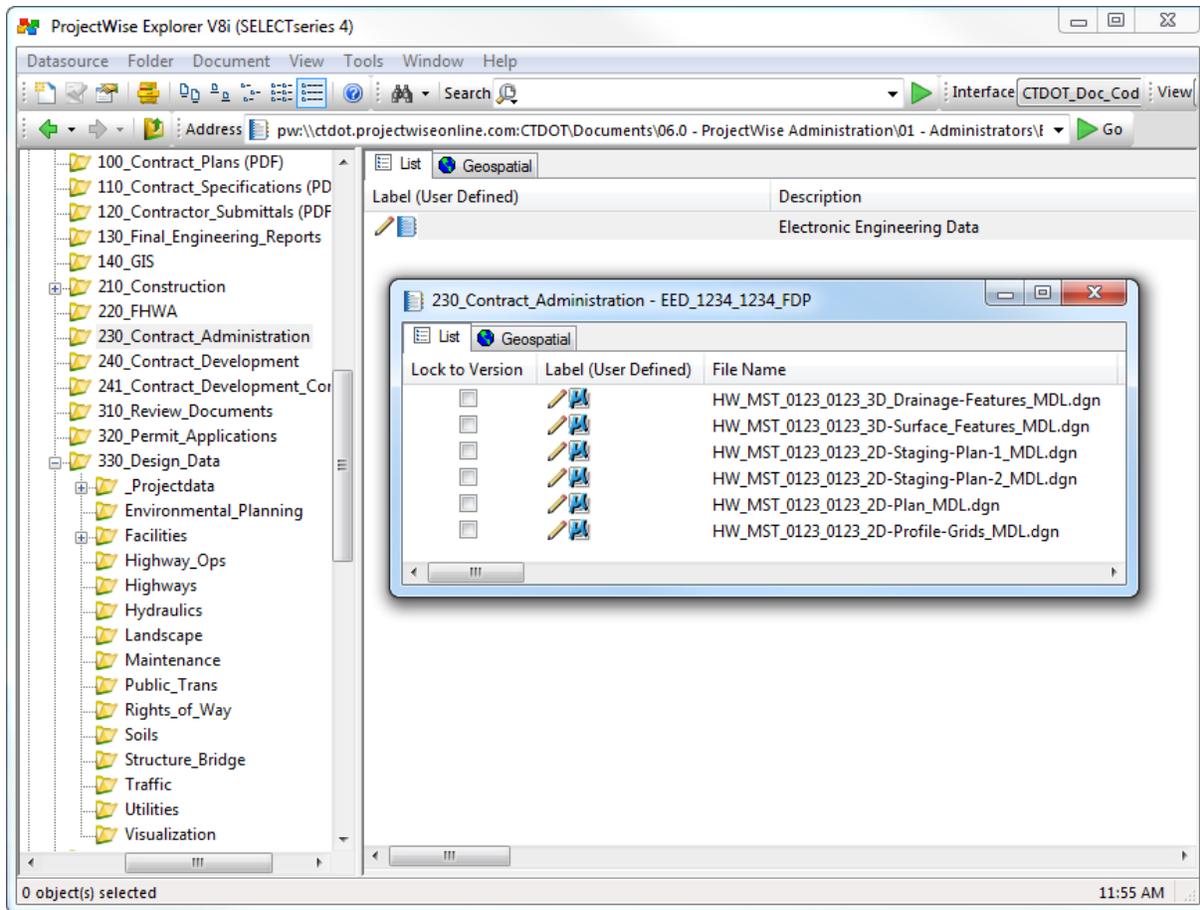
3.3 Submission Procedures

3.3.1 EED Delivery Manifest

The EED delivery manifest must be delivered to the CTDOT with every EED submittal. A blank copy can be found by clicking on the following link: [EED Delivery Manifest](#). This form will include general project information; the datum used for the ground survey; file names and specific information about each EED file being submitted. The contact information for the lead designer and lead surveyor must also be provided.

3.3.2 ProjectWise Thick Client

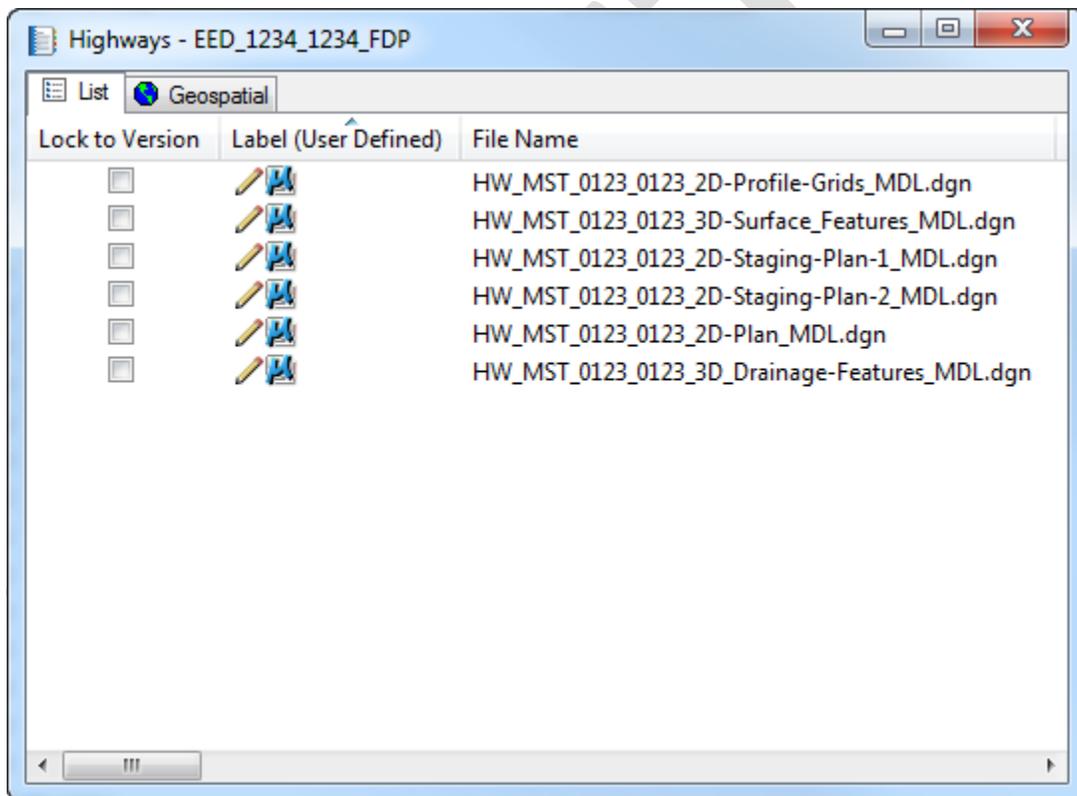
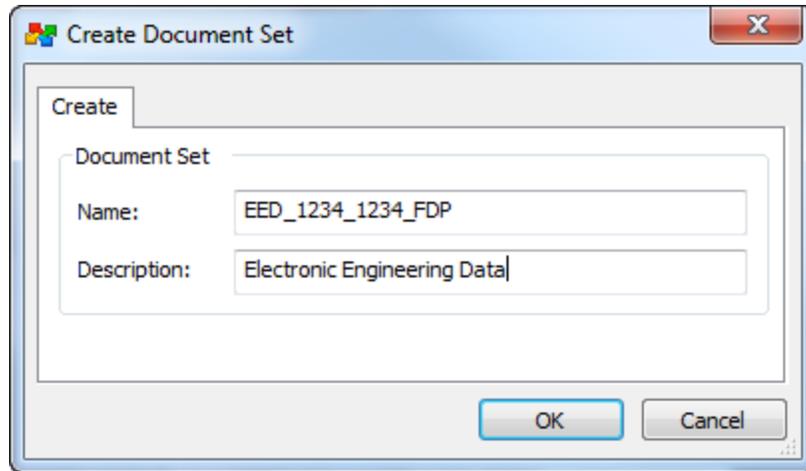
All Design work will be completed inside of ProjectWise > added to a set file in the 230_Contact_Administration folder



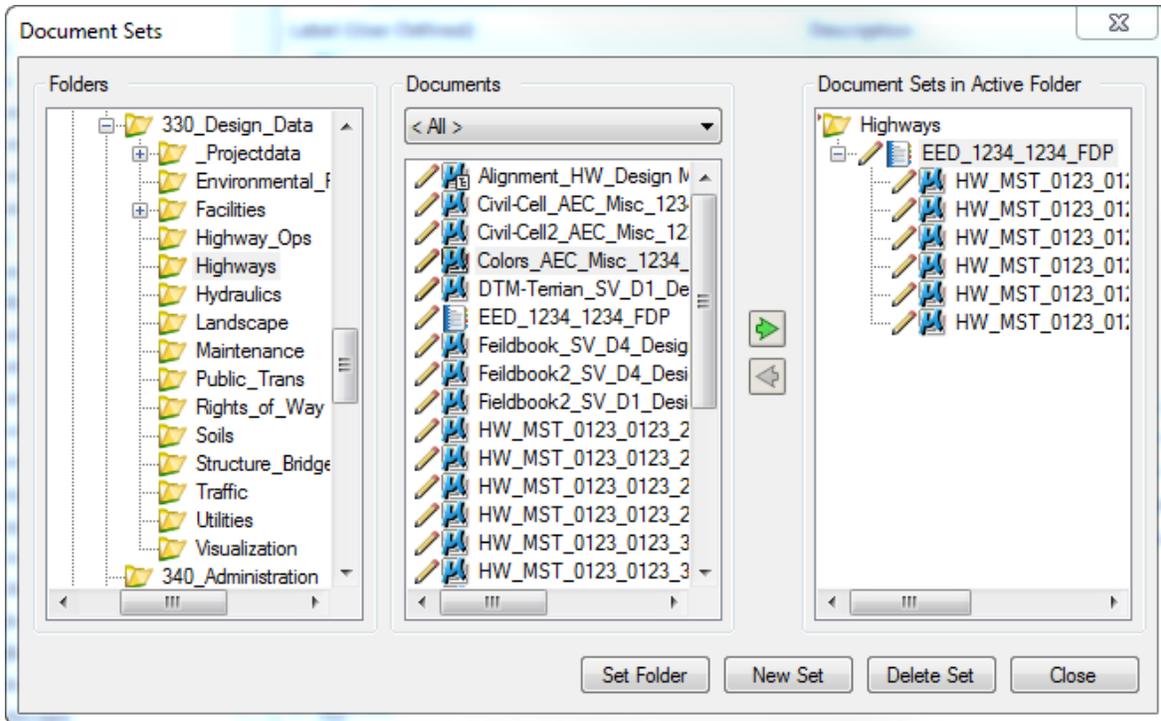
All Design work will be completed inside of ProjectWise > added to a set file in the 230 Contact Administration folder

Figure 3-1 Phase 2 Submission Overview

1. In ProjectWise Browse to the Highway folder and select all the required EED files, right click and select Set > New. Click OK and close the second box that opens.



2. Right click on the Set file and Select Set > Modify. Add the other discipline files to the set.



3. Select Close when complete.
4. Move the Set file to 230_Contact_Administration.

DRAFT

Appendix A Electronic Data Definitions

3D Model – Models includes all engineering data which is geospatially positioned and graphically displayed on project related datums and are used to describe the existing conditions or proposed design of a capital project. This can include multiple DTM surfaces and related Graphics Information. The “Model” is what is generally what is referred to as the deliverable for projects which anticipate using AMG.

Automated Construction and Inspection – Automated Construction & Inspection include all technologies used for the construction and inspection of capital projects, and require the input of reliable EED to operate effectively. Examples of this may include Automated Machine Guidance, Automated Stakeout & Inspection, and Intelligent Compaction operations.

Automated Machine Guidance (AMG) – AMG uses computers and survey technology on construction equipment to automate the calculation and interpolation between a proposed digital terrain surface (or a control alignment with templates) and survey geospatial positioning. This interpolation provides visual horizontal and vertical guidance to the operator of the construction equipment. AMG is also referred to as Machine Control or Automated Machine Operations.

Automated Stakeout & Inspection – Use of computers and survey technology to automate the calculation and interpolation between a proposed digital terrain surface (or a control alignment with templates) and survey geospatial positioning. This interpolation provides horizontal and vertical guidance to the operator of the equipment, for the stakeout of proposed work or positional verification or measurement of completed work.

Digital Terrain Model (DTM) – A DTM is a digital map representation of a three dimensional topographic surface. (Also referred to as Digital Elevation Model DEM, or a Triangulated Irregular Network TIN). DTMs are visualized electronically by draping a surface over triangulated points which are generally determined along breaklines where changes occur in the slope of the surface. The points are defined geospatially by coordinates and elevation values. In the civil engineering industry, DTMs can represent existing natural terrain of the earth’s surface, or proposed terrain intended to represent a completed surface. DTMs can portray triangulated and/or non-triangulated features, shapes and solids.

Documents & Publications – Includes reports, manuals, contract proposals, specifications or other publications which record or document decisions, standards, policies, procedures or other legal requirements related to capital projects.

Electronic Engineering Data (EED) – Includes all types of design project related engineering data which is used for the defining, developing, designing, documenting, spatially locating, constructing, and historical recording on a CTDOT Project. This includes Documents and Publications, Geospatial Data, Digital Terrain Models, and Graphics Information.

Elements – Elements are points or lines which are described geospatially in two or three dimensions.

Features – Features consist of points and lines which may be connected to form geospatial objects, and can be used to form the ground surface displayed in a DTM. Features can be either 3D triangulated (including elevations) or 2D non-triangulated (without elevation). Features store attribute information about the symbology, level, and text.

Finished Grade DTM – FG DTM shall include the entire proposed project surface area which will be disturbed by construction operations out to all limits of work. The FG DTM shall be a true representation of the entire finished surface that the Designer intends to be built. The outer limits of a project's DTM shall include all disturbed/modified terrain surfaces that require excavation or fill of greater than 6" from the existing ground surface over a 1,000 sqft area.

Geospatial Data – This information identifies the geographic position and characteristics of natural or proposed constructed elements, features and boundaries and how they are positioned related to the earth's surface.

Graphics Information – Graphical representations of project information portrayed either by raster or vector images. Files include graphical representations of points, lines or shapes, text annotation, and images. CAD files are generally in MicroStation DGN formats, and include all associated reference files. Graphics are generally published in PDF format.

GPS – Global positioning system, the Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver.

RTK – Real Time Kinematics, Real Time Kinematic (RTK) satellite navigation is a technique used in land survey and in hydrographic survey based on the use of carrier phase measurements of the GPS, GLONASS and/or Galileo signals where a single reference station provides the real-time corrections, providing up to centimeter-level accuracy.

RTN – Real Time Network is similar to RTK yet it uses a network of base stations located on maintenance garages, the internet, satellites and host server software. Though fairly new to the U.S., these types of networks have been very successful in Europe and Asia where networks span entire countries where utilization is spreading beyond surveying to mapping, utilities, emergency response, agriculture, forestry, public safety, transportation, machine control for construction, environmental, and scientific research.

Appendix B Benefits

Construction operations which may produce the greatest productivity gains by the use of EED are for material excavation or placement. Construction items which optimize the efficiency and accuracy of AMG are earth excavation, fill and subbase courses. These items are all volume measured and their quantities can directly be calculated from the terrain models for the existing surface, the finished grade surface, and the top of subgrade surface.

Other construction installations which would benefit most from providing EED for stakeout and inspection verification are bridge substructures, public and private utilities, curbing, sidewalks, commercial driveways, signs, lighting & signal posts, and pile driving. Bridge superstructure and substructure layout could be modernized to provide contractors with 2D or 3D spatial descriptions (features) of all structural elements and critical control lines. This information could be used by AMG for the excavation of the footings, backfills up to finished grades, by pile drivers to position proposed pile locations, by carpenters to automate the layout and building of concrete forms, by steel workers to automate the positioning of steel supports and for installing of reinforcement, and by DOT Inspectors to verify the correct spatial locations.

Projects which do not contain 3D DTMs can also benefit from using supplied EED. Sign or guiderail replacements, or pavement striping contracts could benefit from locations derived by GIS approximated or GPS field measured 2D coordinates for positional locations. Using geospatially described locations (coordinates) or station-offsets provided by alignment files instead of record plan scaled stations and offsets will provide more clearly defined designer intent as to the location of the items.

General:

- Greater ease of design implementation at time of construction.
- Enhanced quality of constructed facilities.
- Greatly reduces the need for construction staking which in turn reduces survey costs
- Contractor and agency labor savings when measuring and documenting as-built quantities and pay-quantity management.

Design:

- Increased accuracy and data intelligence going into design.
- Enhanced visualization capabilities during the design process.
- Identify clashes and constructability issues prior to construction.
- Greater accuracy for quantity computations

Construction:

- Points or alignments of features can be used by Contractors to locate items in the field by using Total Stations or GPS/RTK survey equipment (available in CT).
- Breaklines, features and other alignments included with digital terrain models (DTMs) are used by Contractors for Automated Machine Guidance (AMG) operations. Use of GPS for AMG allows for the most efficient operation of earthwork machinery, less operator time is required for construction, idle time and rework.

- Uniform compaction
- Check constructability
- Track stage construction
- Improved Safety
- Equipment resource savings
 - Machine idle time can be reduced when there is less waiting for excavation and embankment staking and clarifications.
 - Finish grading iterations are lessened or nullified because of GPS accuracy, therefore resulting in a reduction of machine hours.
- Earthwork construction tasks are shortened because:
 - Contractors can mobilize to the site and begin work without waiting for surveyors to position grade stakes for the initial lifts.
 - Checking grades and rechecking spot locations immediately versus calling and scheduling a survey crew.
 - Time saved in layout and grade checking can be devoted to machine movement and cycle time efficiency.
 - Reduction in rework - Jobsite grade and location errors are more easily spotted and corrected with GPS technology than with reliance upon 2 dimensional drawings and surveyor's grade stakes.
 - Construction field managers can make decisions more quickly and accurately because position and grade information is provided in real time.

Construction Inspection:

- Accurate quantity take off for pay-items (point locations, areas, volumes)
- Pay-items are easily tracked
- A single person can locate and document exact x,y,z positions providing real-time verification of an item being inspected or a point location being disputed.
- Reduction of conflict resolution time.
- Electronic as-built data can be produced and easily incorporated on the electronic contract plans either during construction ("live" as-builts) or post construction.