MaineDOT Review of Contractor Model

Process Flow for Review of 3D Model in InRoads

1 Process Summary

3D MODELING AND AMG

Background

The MaineDOT considers the use of Automated Machine Guidance (AMG) by Contractor for MaineDOT Projects, to be a desirable process. Used effectively, AMG provides a method to accelerate highway construction, while improving quality and safety.

The MaineDOT has updated Standard Provision 105.6 Construction Surveying to address the use of 3D Modeling in the AMG Process. Currently 3D Models created by the Contractor are used to control the Guidance of Construction Equipment. In order to facilitate this process the Department provides 3D CADD data to the Contractor, and reviews the Contractor's 3D Model to confirm compliance with the Contract Documents.

- 105.6.2.2 Electronic Design Data and Digital Terrain Model (DTM)

"If provided by the Department, at the request of the Contractor, any electronic project design data will not be deemed a part of the contract, and is supplied as a courtesy by the Department. The Contractor shall not take advantage of any ambiguity or error contained in said data, and upon discovery of any ambiguity or error shall notify the Department before proceeding."

Process Overview

The Review of a Contractor's 3D Model is initiated by the Receipt of the 3D Model; per Standard Specifications the format of the model should be either an InRoads Surface (.dtm) or LandXML (.xml) file. Any other format may be accepted, at the discretion of the Design Team.

The review is typically made by one or more of four methods. These are:

1. Creation of an Isopach Surface based from the Contractor's Model, and the Design Model. This surface will have an elevation (Z) based on the difference between the two surfaces; so indication of an elevation of 0.0 indicate that the 2 surfaces are identical at that location.
    a. While this is a very thorough technique for the review of the Contractor's Model; it relies on the Designer's 3D Model to provide a basis for anaylsis. Locations where the Designer's 3D Model differs from the Contract Plans, are not available for analysis by this technique.
2. Display the Contractors Surface on the Cross Sections created as part of the Contract Documents. Coincident lines are an indication that the surfaces are the same at this Cross Section Station.

   a. This technique checks the Contractor Model against the Contract Plans, so provides a checking option when the Designer's 3D Model differs from the Contract Plans. The problem is that it only checks at the location of the Cross Sections (typ. Every 50')

3. Comparison of Features with Contract Plans. Many features can be reviewed by comparing the Contractors Model with the Plan View .dgns This is typically a convenient way to determine whether the Cut / Fill Slopes terminate as desired.
   a. Care should be exercised as the Contractor's Model may not have an associated Exterior Boundary, to limit the triangulation. This may display as triangulation across areas where no work is proposed.
4. Comparison of the Contractors 3D Model with the Right of Way Plan can identify Right of Way Conflicts.

The review process is completed when the comparisons indicate that the Contractors 3D Model do not deviate from the Contract Plans by more than the tolerance for the item being installed. The tolerance(s) can be found as part of the Standard Specifications.

Any deviation from the Design Surface , above the item tolerance, should be noted and the Contractor notified by contact with the Project Manager and/or Project Resident.

When the surfaces are within tolerance, the Engineer of Record should provide documentation to the Project Manager and Construction Resident, indicating the name, size and date of the Contractors 3D Model file that was evaluated, stating that Model met the "Design Intent".

2 Contractor Model Import

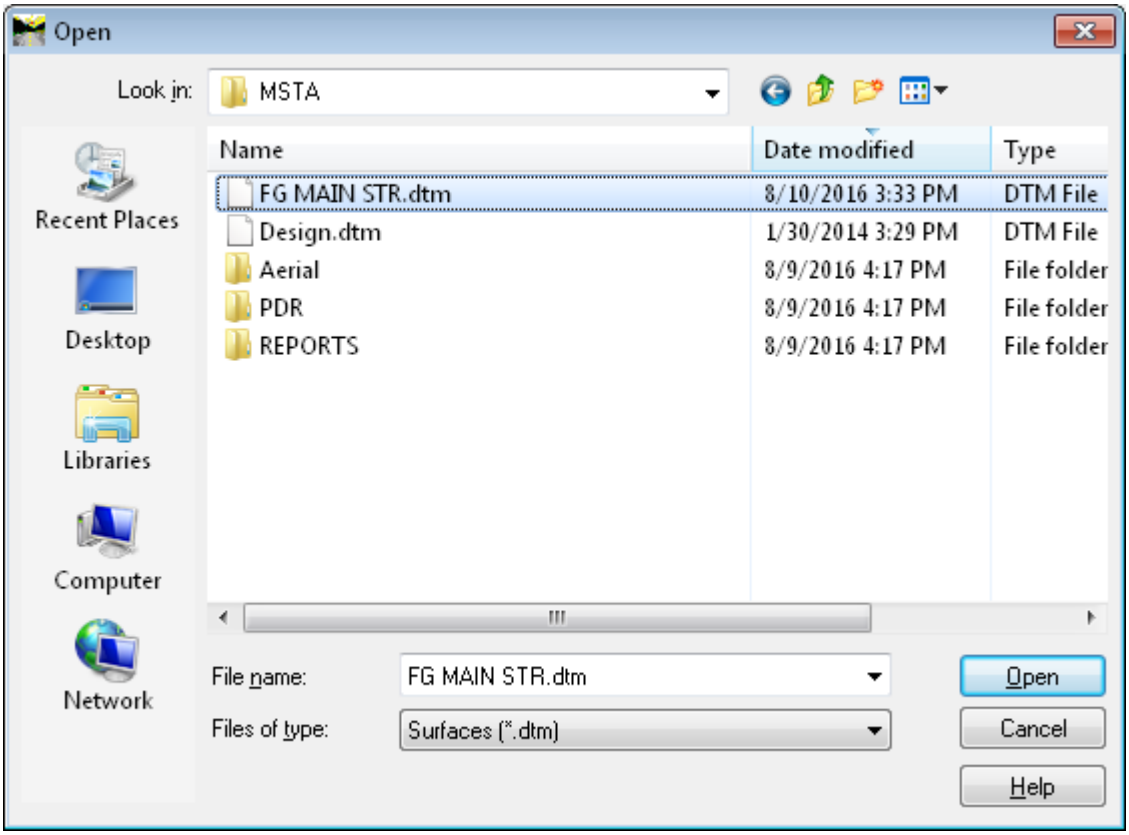
IMPORTING THE CONTRACTOR 3D MODEL

Overview

Models for the Contractor are specified to be either InRoads Surface (.dtm) or LandXML (.xml) format.

Opening InRoads .dtm

InRoads Surface file (.dtm) files can be directly imported into InRoads via the **File** > **Open** menu in InRoads.



Importing LandXML .xml

While intended as a Universal Format; the LandXML Surface file (.xml) files ***cannot*** be directly imported into InRoads.

LandXML Surface files are formatted in a Points section and a Faces section.

```
C:\pin\Cont-Rev\00\HIGHWAY\MST/ | C:\pin\Cont-Rev\00\HIGH...
Page ▾ Safety ▾ Tools ▾
    </Units>
  - <Surfaces>
    - <Surface name="DESIGN LW DGN-FN">
      - <Definition surfType="TIN">
        - <Pnts>
            <P id="1">241152.68418590 961701.53654822 86.423694</P>
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            <P id="6">241139.84668947 961719.16845302 85.757298</P>
            <P id="7">241136.91268533 961723.21443564 85.610178</P>
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            <P id="11">241157.02655243 961710.85947321 85.936153</P>
            <P id="12">241154.08286567 961714.89908227 85.808611</P>
            <P id="13">241151.13917890 961718.93869133 85.681069</P>
```



```
C:\pin\Cont-Rev\00\HIGHWAY\MST/ | C:\pin\Cont-Rev\00\HIGH...
Page ▾ Safety ▾ Tools ▾
          linearUnit="USSurveyFoot" areaUnit="squareFoot"/>
    </Units>
  - <Surfaces>
    - <Surface name="DESIGN LW DGN-FN">
      - <Definition surfType="TIN">
        + <Pnts>
        - <Faces>
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            <F>26 6 27</F>
            <F>8 19 7</F>
            <F>720 719 890</F>
            <F>24 6 25</F>
            <F>11 10 1563</F>
            <F>2073 21 2074</F>
            <F>27 15 14</F>
            <F>22 21 2073</F>
            <F>1 2 1563</F>
            <F>1733 22 1848</F>
```

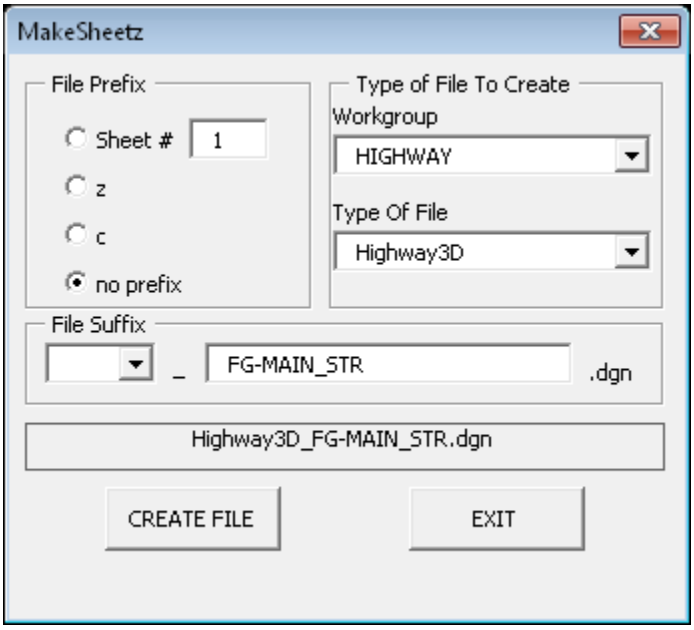

Using the LandXML Translator from within InRoads, through the command **File > Translators > LandXML Translator** ***will not*** import the TIN Faces, so InRoads will prompt to create a triangulation, which can force triangulation across featured which should be breaklines.

Note: This example can be found on the Y: drive in a folder named Cont-Rev. This folder should be copied to the local C:\pin\ folder. The file Design.rwk can be loaded from the C:\pin\Cont-Rev\00\HIGHWAY\MSTA folder. In order to use the sample project load the Cont_Rev_00.pcf file from the folder into the C: /!msproj/ folder.

In order to import the LandXML file correctly the following procedure should be performed.

Step One

From the **File > MakeSheetz** macro create a 3D plan view file that reflects the name of the LandXML file being opened.

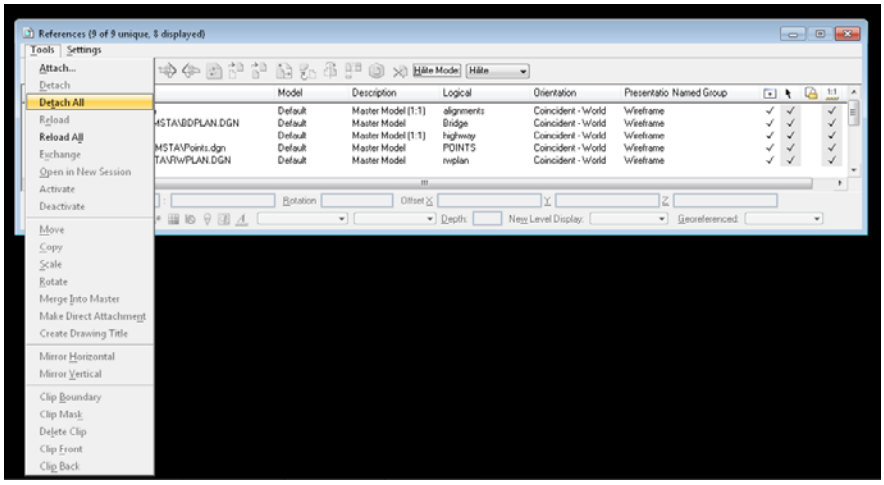


The file created will have a series of References attached and opened. These References may be distracting when conducting the review, as they may display multiple copies of the same feature, some 2D and some3D.

These References can be eliminated from the drawing by the command(s):

File > Reference (DOT) > Dialog

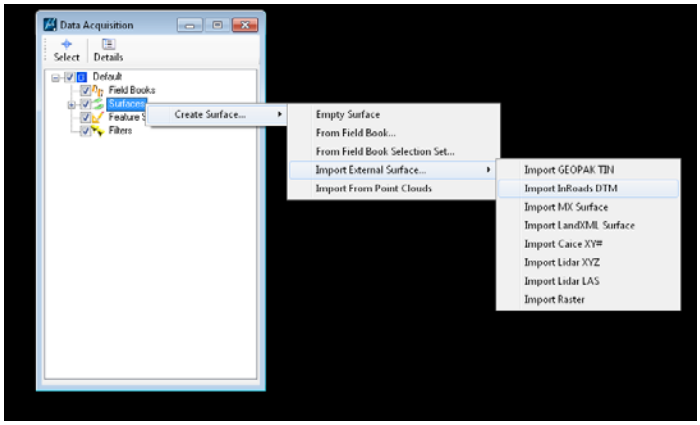
Tools > Detach All



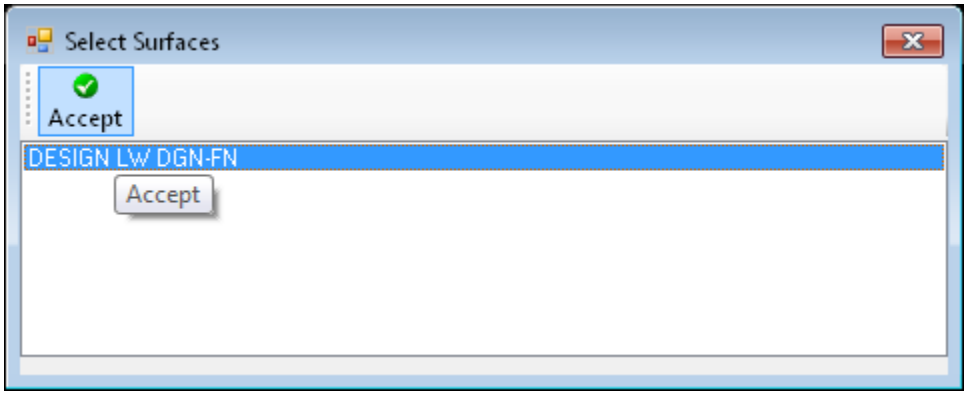
Step Two

Launch the **Data Acquisition** menu from the **Tasks Toolbar.** The **Data Acquisition command** can also be accessed from the **Tools** menu.

From the **Surfaces** tool **Right-Click** to open the **Create Surfaces > Import External Surface > Import LandXML Surface.**



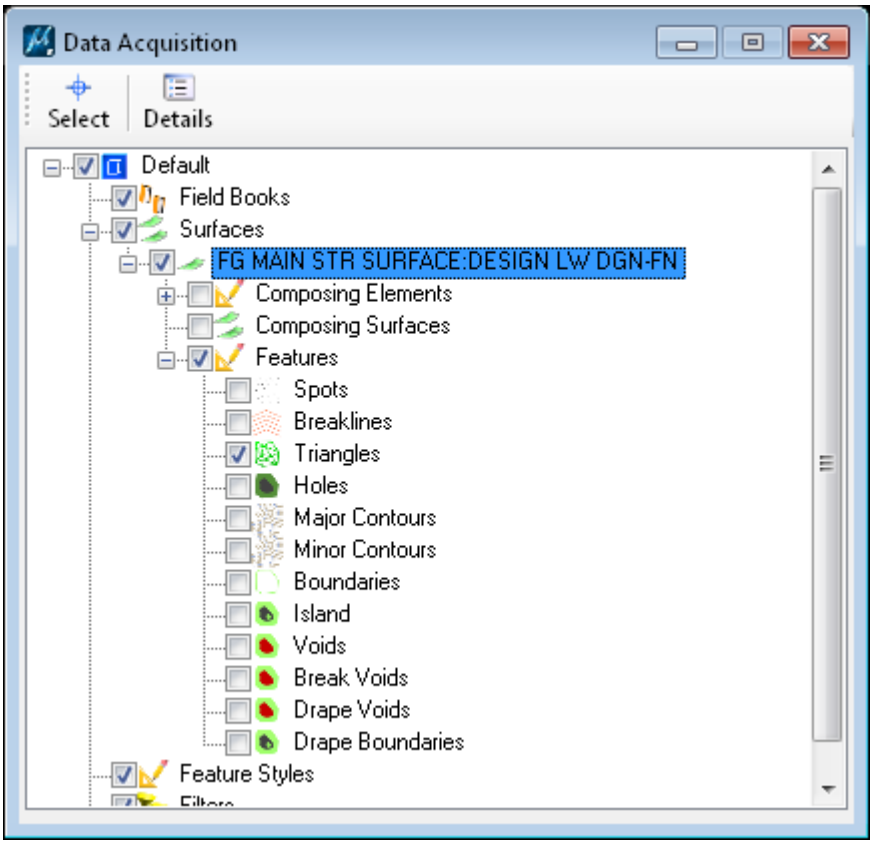
Select the file **FG MAIN STR SURFACE.XML** and press **Open**



From the Select Surfaces dialog box, Highlight the Surface Name and Press **Accept**

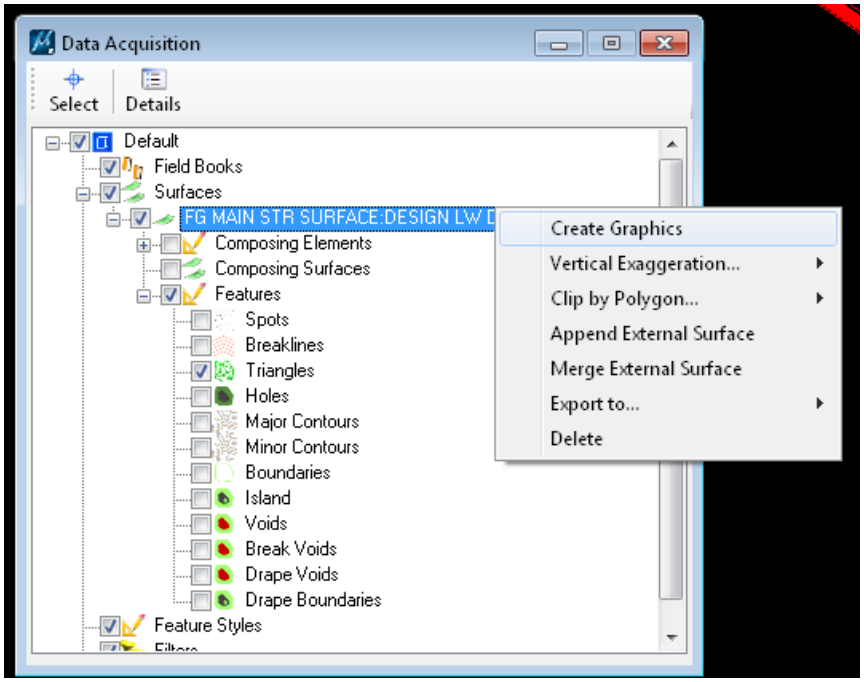
Step Three

After the Surface is imported turn off the display of all elements except the Feature "Triangles".

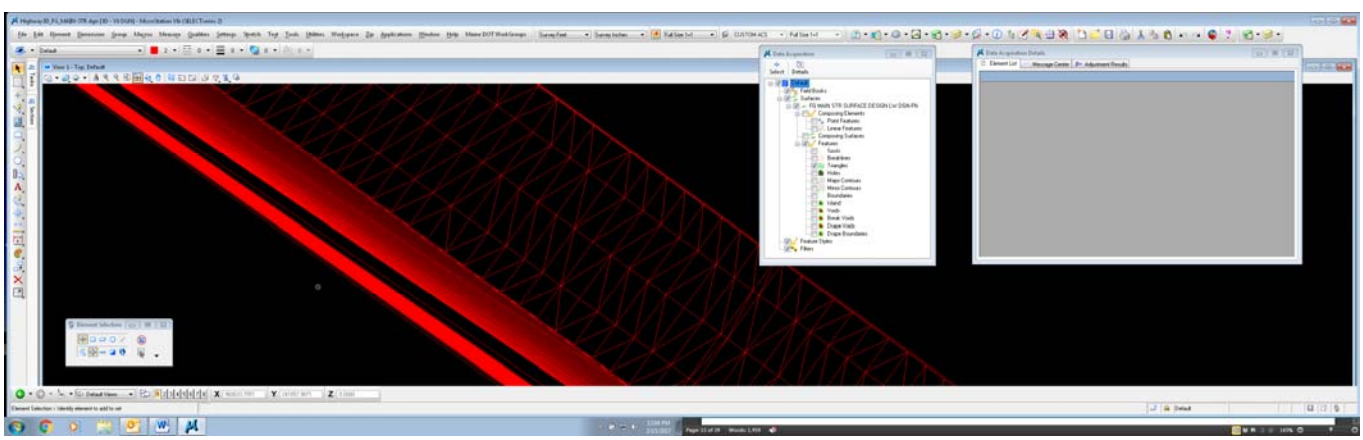


Step Four

Right click on the surface name, and select Create Graphics. This will write the triangles to MicroStation.



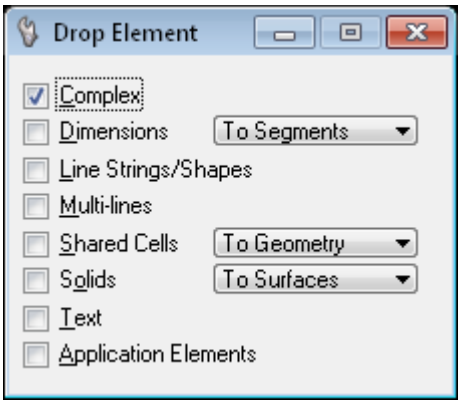
Press **Fit View** to view the imported Triangles.



*****NOTE***** As the result of there not being an External Boundary imported with this data extraneous triangles will be created on the inside of any curved portion of the surface.

These triangles should not be used to determine the validity of any 3D Models, and can be removed by using the Drop Element tool to drop the Mesh.

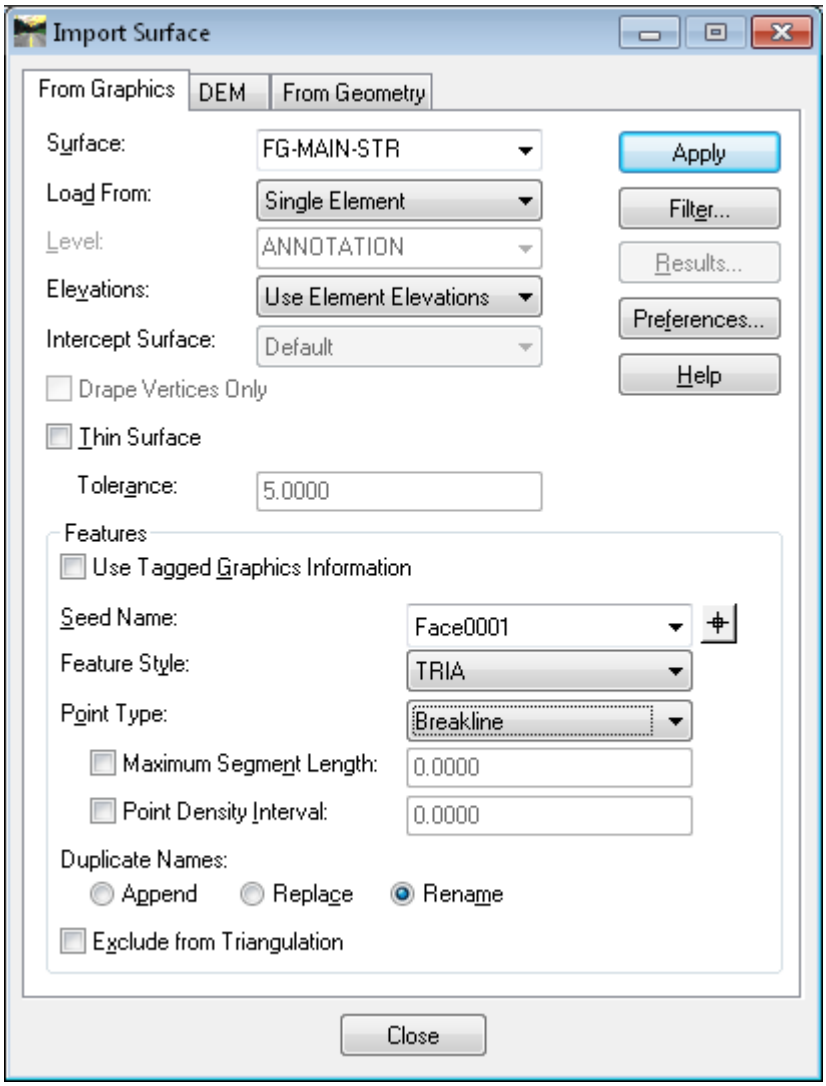
Qualities > Drop > Complex



Step Five

After the graphics are created, create a Selection Set from the Triangle legs, by **Edit > Select All.**

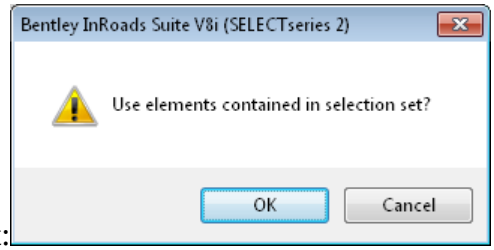
From the InRoads menu the graphics can be imported into a surface by the command **File > Import > Surface > From Graphics**



Provide a **Surface** name that is consistent with the name of the Contractor's Model, or which provided enough descriptive information to know what the surface is.

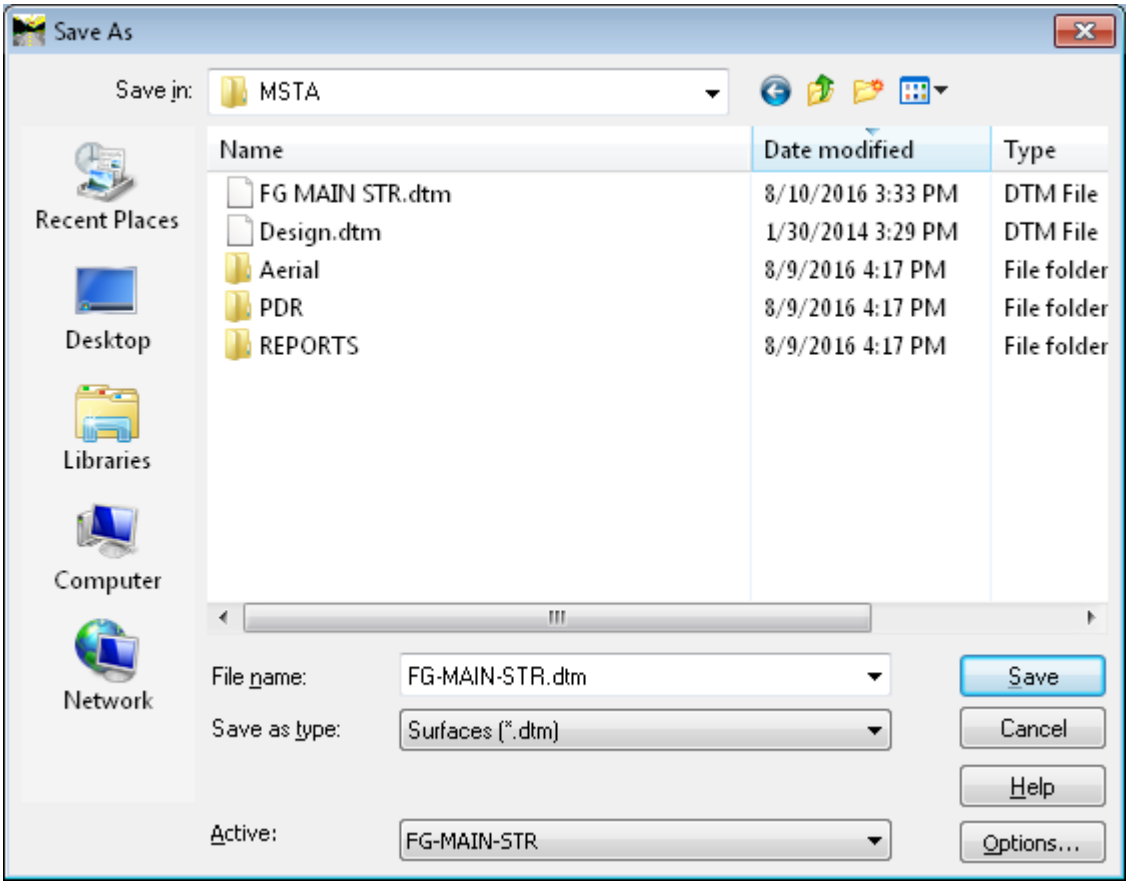
By having a Selection Set of all triangle legs created before the Surface is created the **Load from: Single Element** can be used.

Click **Apply**

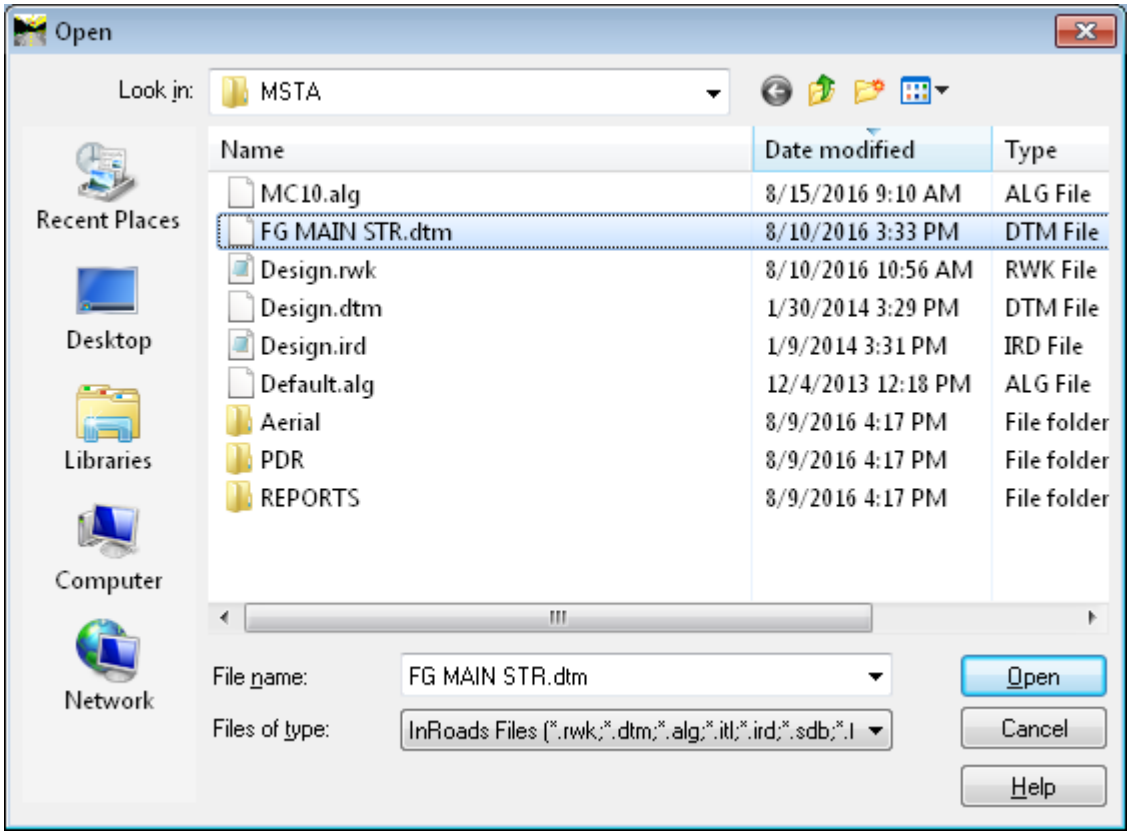
At the prompt: 

Click **OK**

Save the created surface.



From the InRoads menu select **File** > **Open** and open the newly created surface.



Right Click the surface name and **Set Active.**

REVIEWING THE CONTRACTOR 3D MODEL

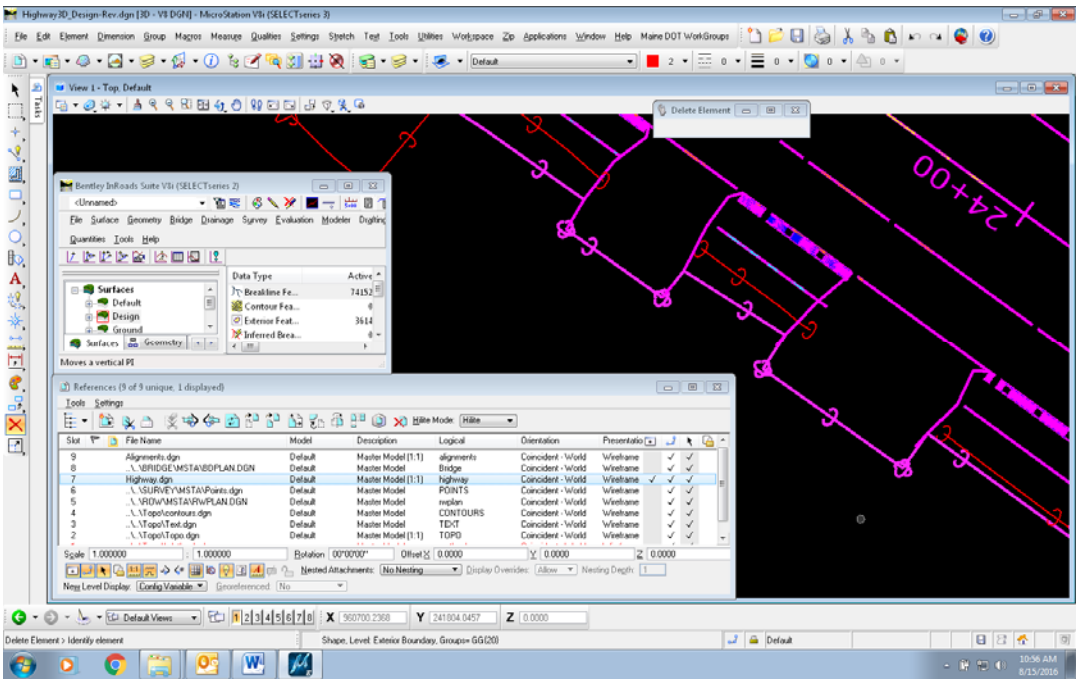
Overview

Now that the Contractor's Model has been imported into an InRoads surface; the InRoads tools can be employed to compare the Contractor's Model to the Plan Set, and the Design Model.

Reviewing Design Model

The first step in reviewing the Contractor's Model is to identify locations where the Design Model is inconsistent with the Plan Set. One way to identify these locations is to **Reference** the Design Model into the base drawing for the Plan Set.(Highway.dgn)

This process will allow us to identify the Horizontal variances in feature between the two Surfaces.



In this instance it appears that edits were made on the Cut/Fill lines in Plan and Cross Section, after the Model was created. The Roadway Centerline, Edge of Travelway and Shoulder, appear consistent between the Plan and 3D Model.

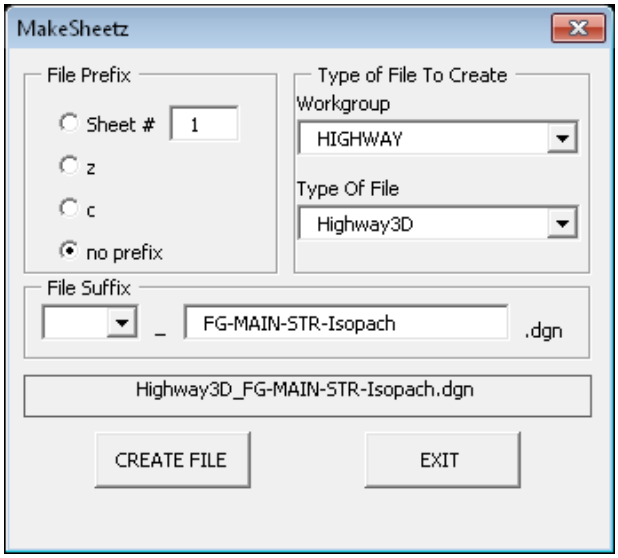
In areas where the Design Model deviates from the Plan Set, Plan Set information needs to be used to access accuracy.

Reviewing Contractor Model against Design Model

After determining areas where the Design Model is inconsistent with the Plan Set, InRoads can be utilized to compare the two surfaces. This is accomplished by using the 2 surfaces to create an Isopach surface. The Isopach elevation represents the difference between the elevation of the surfaces. This elevation difference can be judged against the allowable tolerance for the work to be performed.

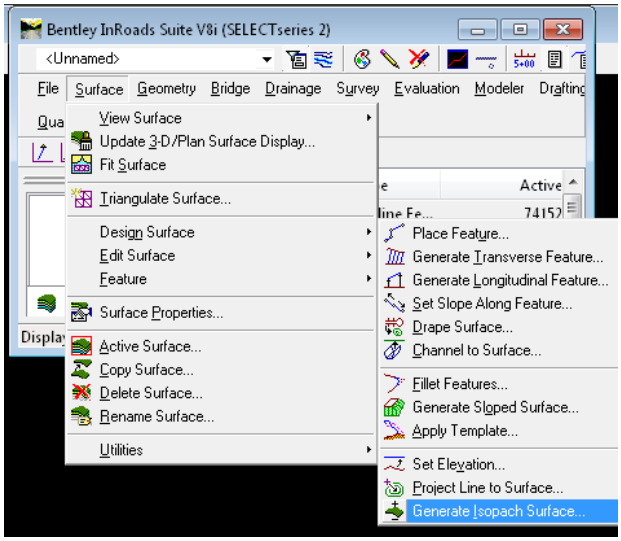
Step One

From the **File** > **MakeSheetz** macro create a 3D plan view file that reflects the name of the Contractor Model, and that this will be an Isopach Surface.

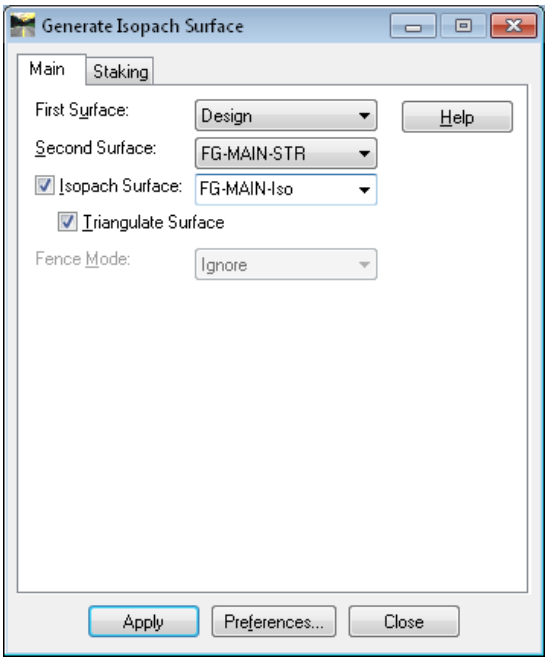


Step Two

From the InRoads menu, select **Surface** > **Design Surface** > **Generate Isopach Surface**

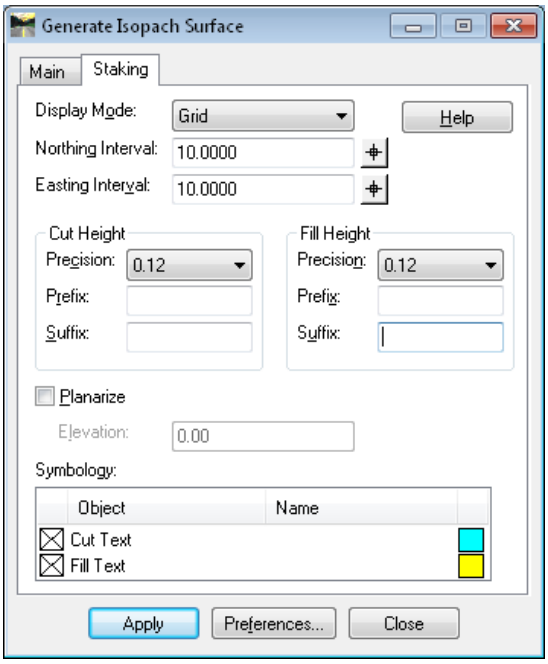


From the Main Tab, select **First Surface** and **Second Surface**; and enter the name of the Isopach Surface to be created.

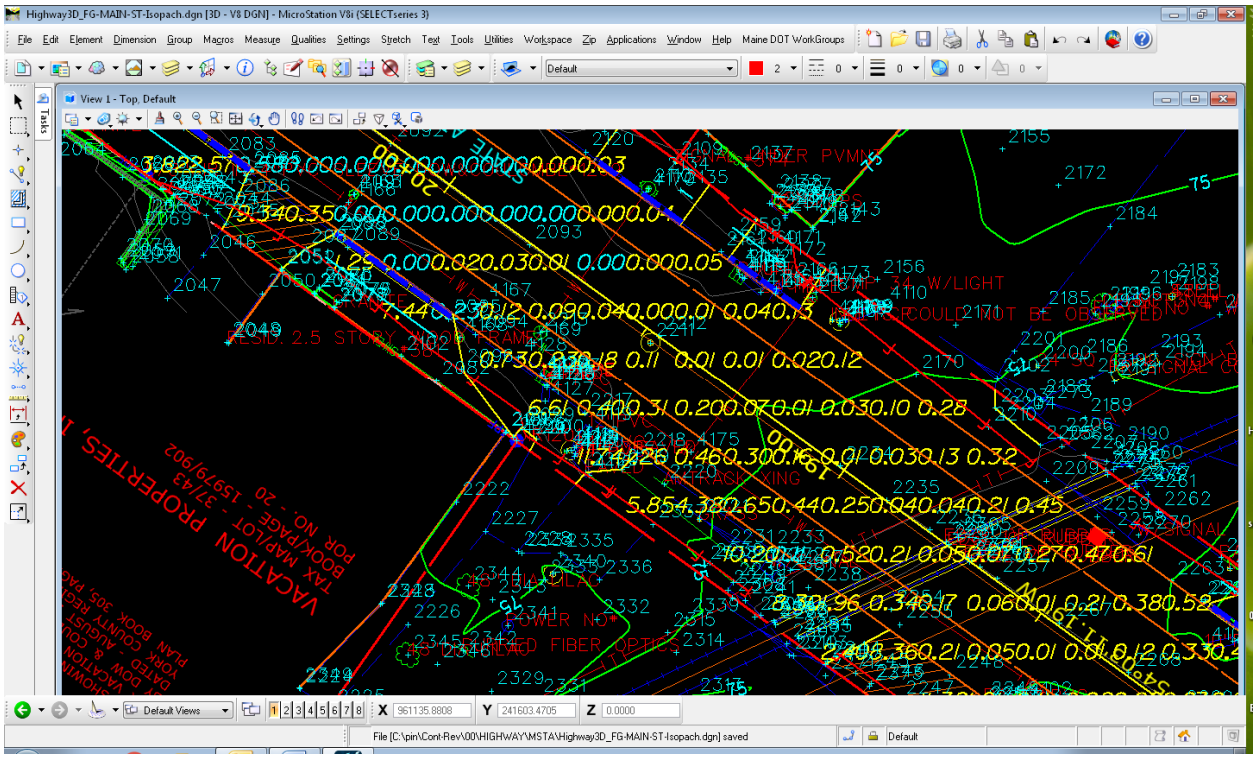


From the **Staking** tab, Select the **Grid** Display Mode, and an Interval of 10'. Select a **Cut & Fill Height Precision** of 2 decimal places (0.12). Delete all **Prefix** and **Suffix** options.

These selections will provide a listing of the elevation difference every 10'; which is about as close as is possible with this text height.

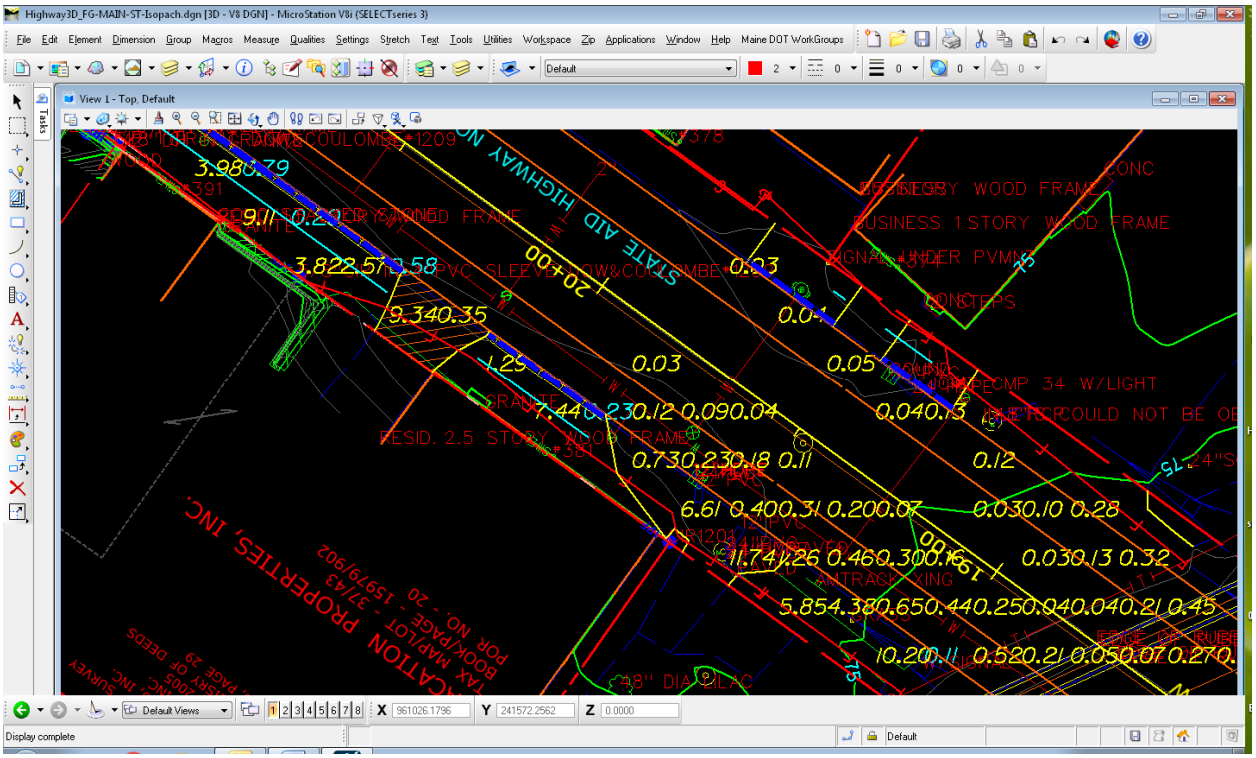


Press **Apply** to create the Isopach surface.



This output is shown with the Reference files displayed. This allows locations to be identified and determines the edges of the paved area.

In order to simplify the output and remove extraneous infromation the MicroStation command **Edit > Find/Replace Text** can be used to remove the 0.00’, 0.01’, and 0.02’ elevations.



From the resulting output, areas having differences that should be noted, and reviewed can be identified. In this display much of the upper roadway looks good (< 3/8”), but areas in the lower section have differences approaching 0.5’.

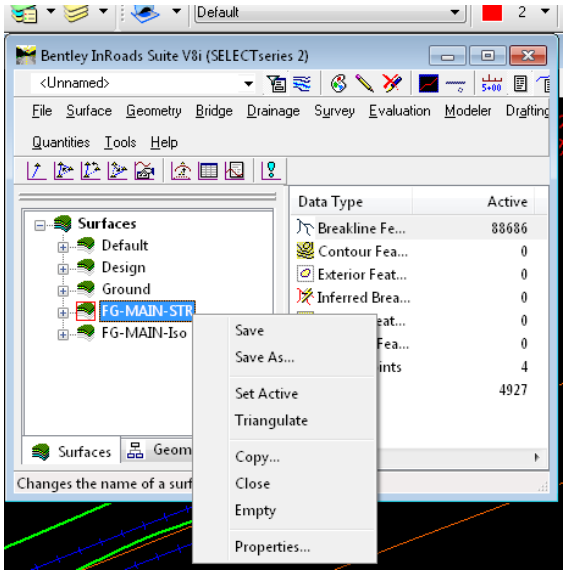
REVIEWING THE CONTRACTOR 3D MODEL IN CROSSSECTION

Overview

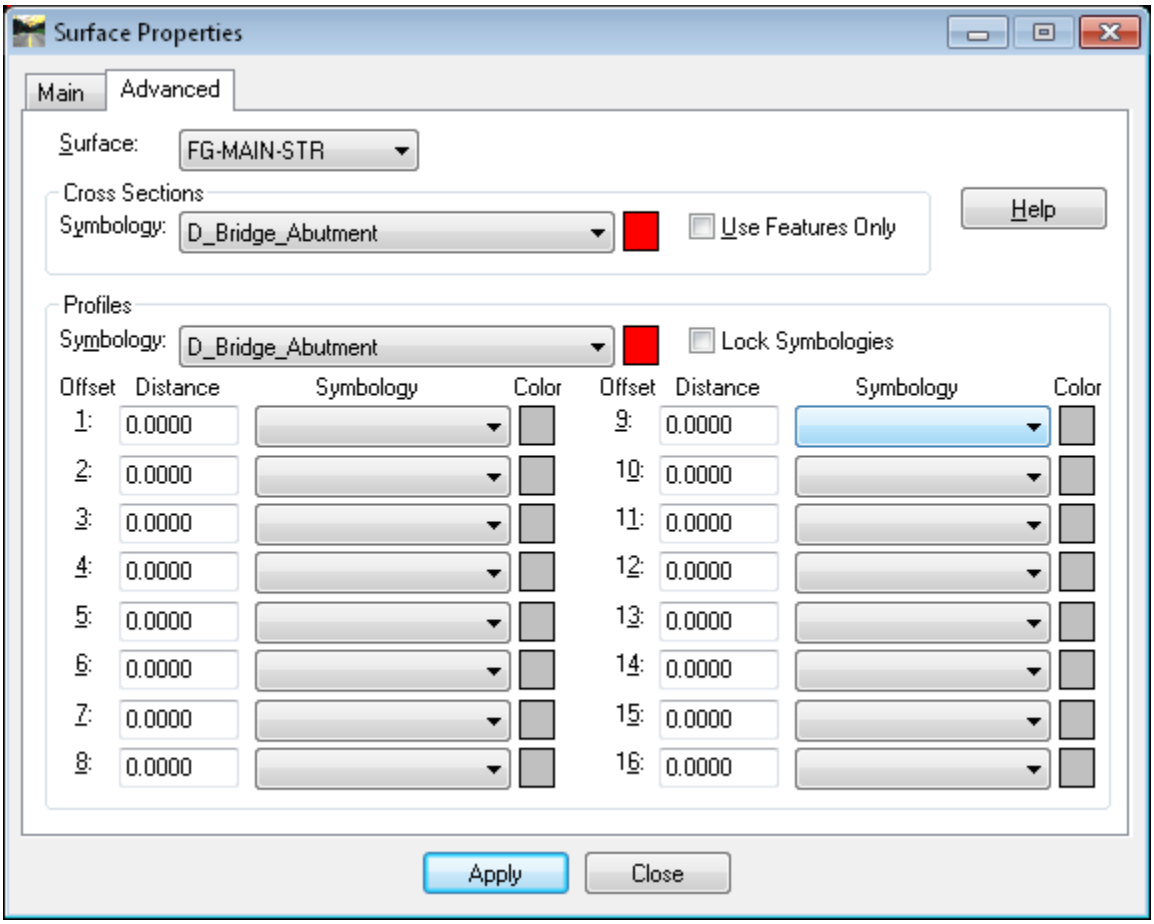
Now that the Contractor's Model has been imported into an InRoads surface; the Contractors Finish Grade Surface can be displayed on the existing Cross Sections to further identify deviations from the Plan Set.

Modifying Contractors Model

In order to visualize the Contractor's Model easier, the Properties of the Finish Grade Surface (not the Isopach surface) will be modified. **Right Click** on the Surface and **Click** Properties



In the Advanced Tab of the Surface Propertied dialog, change the Symbology to a color and linestyle that is more visible. In this case, the Symbology D_Bridge_Abutment is chosen. Then press **Apply**.

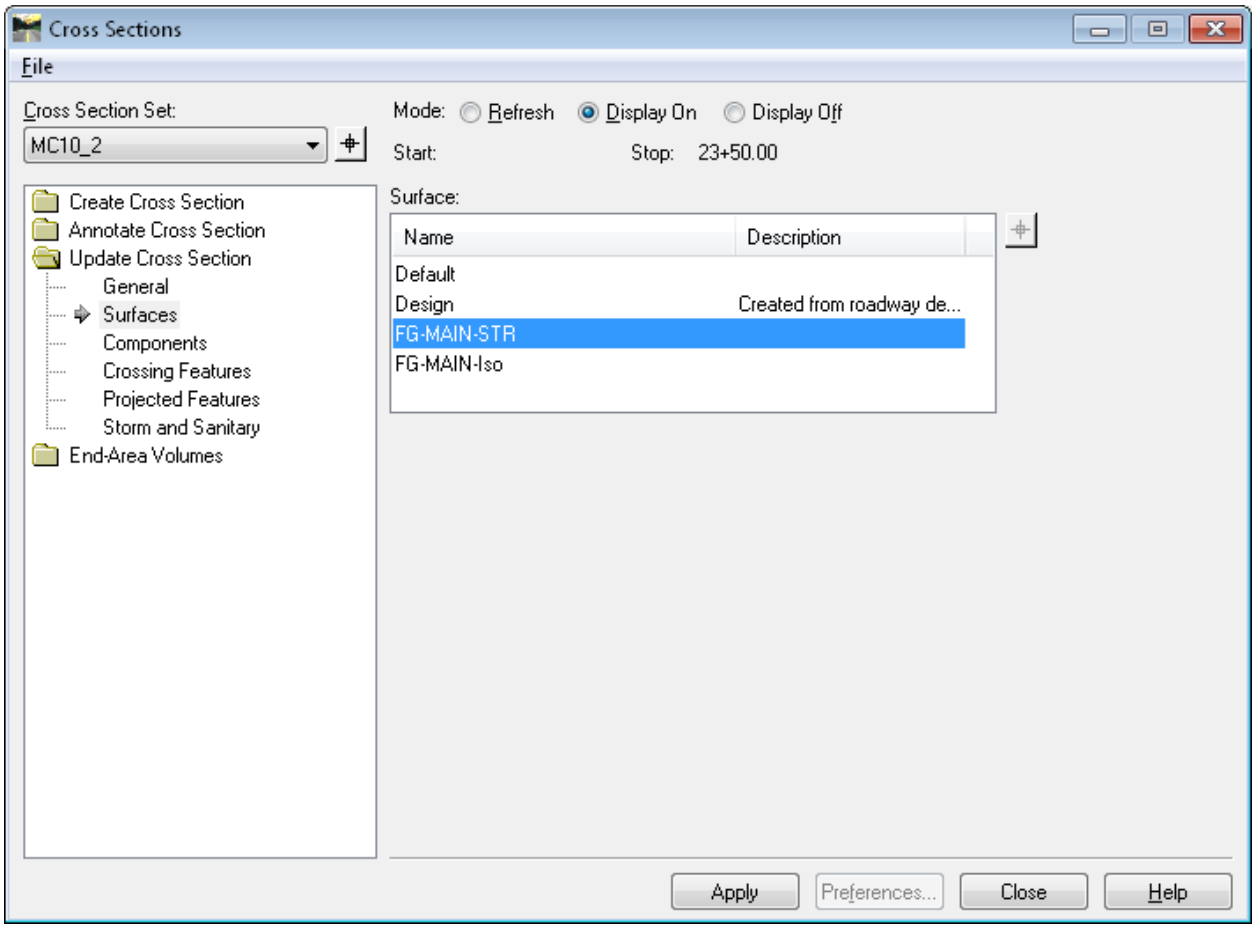


Viewing the Contractors Model in Cross Section

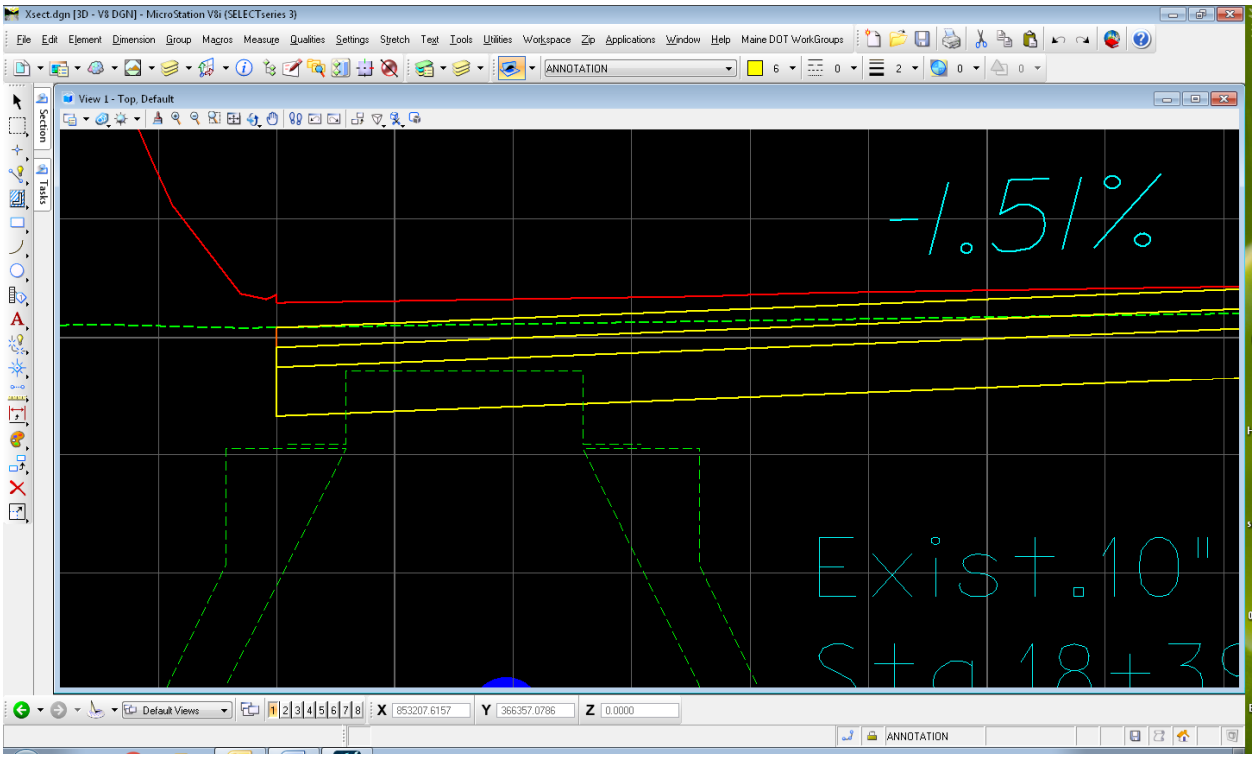
Open the Cross Section sheet drawing (Xsect.dgn) that was the basis of the Cross Sections in the Contract document.

From the InRoads menu select the **Evaluation > Cross Section > Cross Section**.

Choose the Set Name of the Contract Set of Cross Sections. In the **Update > Surfaces** dialog, select **Display On**, highlight the Contractors Finish Grade Surface and select **Apply**



In the Cross Section drawing the offset and elevation of the Contractor's Model can be viewed and compared, at each Cross Section Station.


Xsect.dgn [3D - V8 DGN] - MicroStation V8i (SELECTseries 3)
File Edit Element Dimension Group Macros Measure Qualities Settings Stretch Text Tools Utilities Workspace Zip Applications Window Help Maine DOT WorkGroups
ANNOTATION
View 1 - Top, Default
-1.51%
Exist.10"
Sta 18+30
Default Views
X 853207.6157
Y 366357.0786
Z 0.0000
ANNOTATION

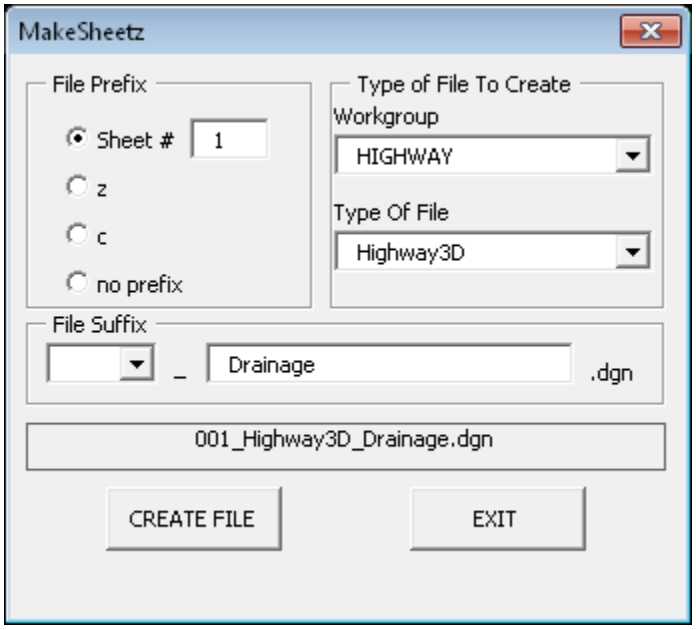
REVIEWING THE CONTRACTOR 3D MODEL DRAINAGE

Overview

Now that the Contractor's Model has been imported into an InRoads surface; the Contractors Finish Grade Surface can be displayed using InRoads Slope Vectors tools to evaluate the surface flow direction.

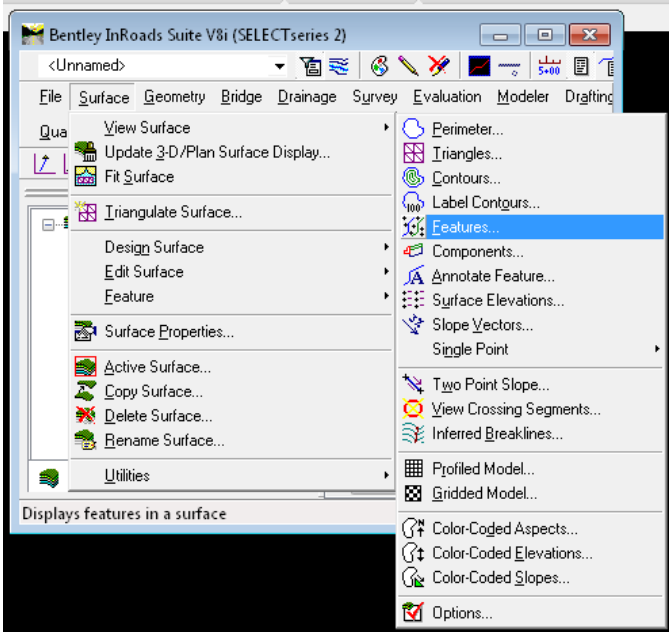
Step One

From the **File > MakeSheetz** macro create a 3D plan view file that reflects the name of the LandXML file being opened and that Slope Drainage is being checked.

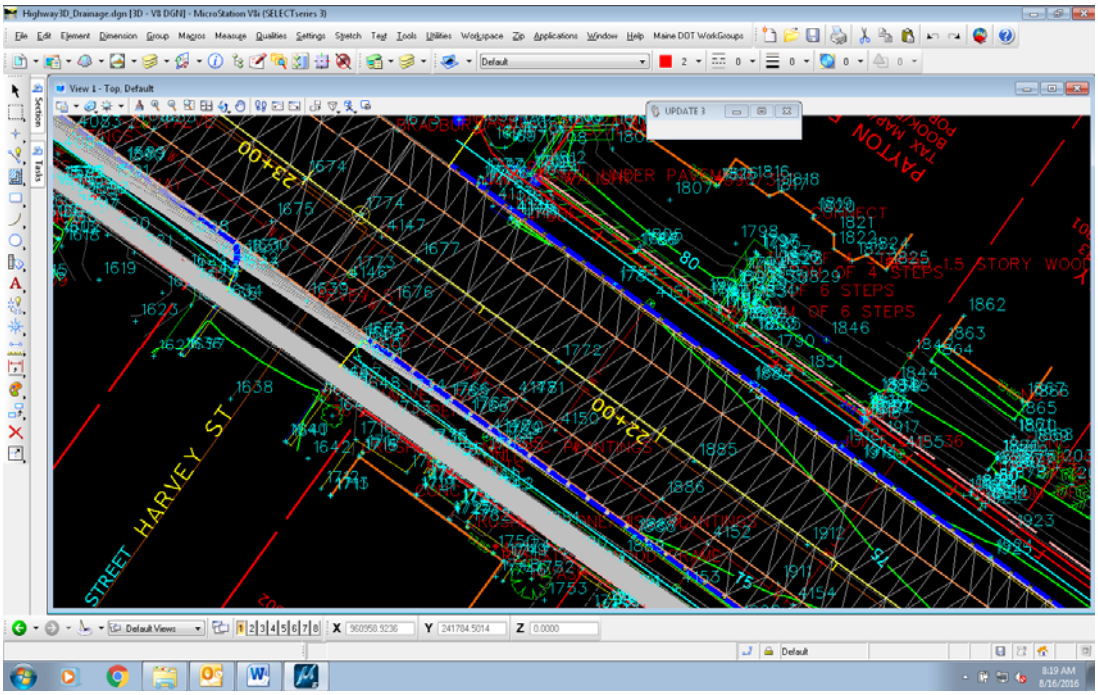


Step Two

From the InRoads Menu **Surface > View Surface > Feature** display the triangulation of the Contractor's Model.



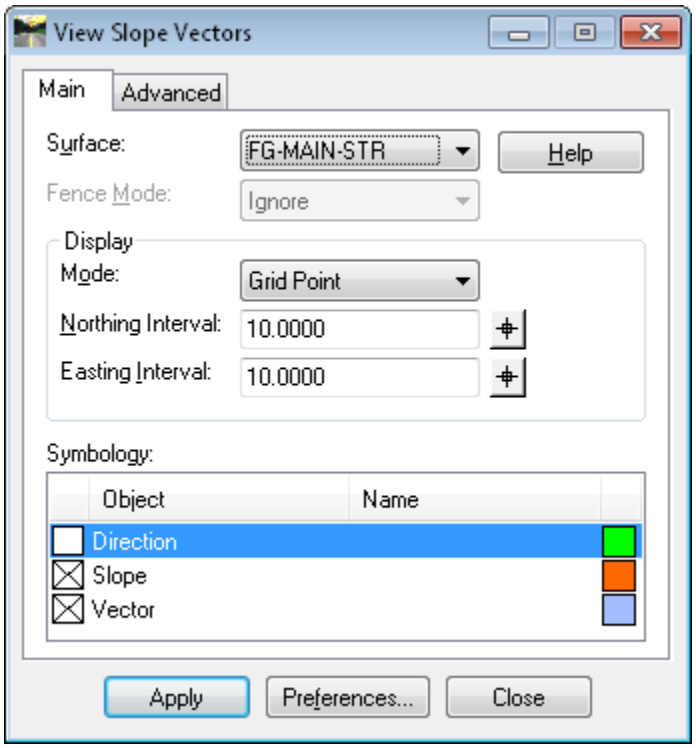
With the Reference files attached the Existing Conditions and Proposed Design Features are visible.



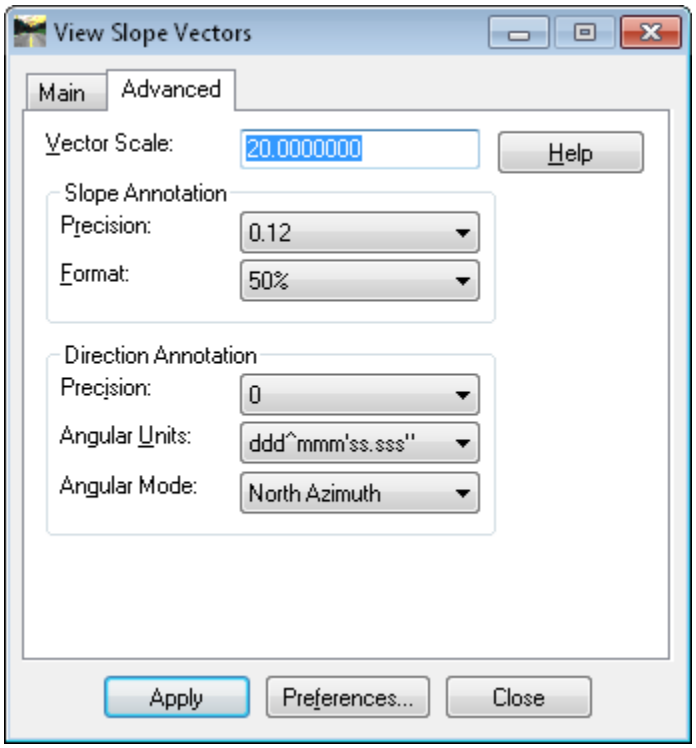
Step Three

From the InRoads Menu **Surface > View Surface > Slope Vectors** display the slope and direction of the Contractor's Model.

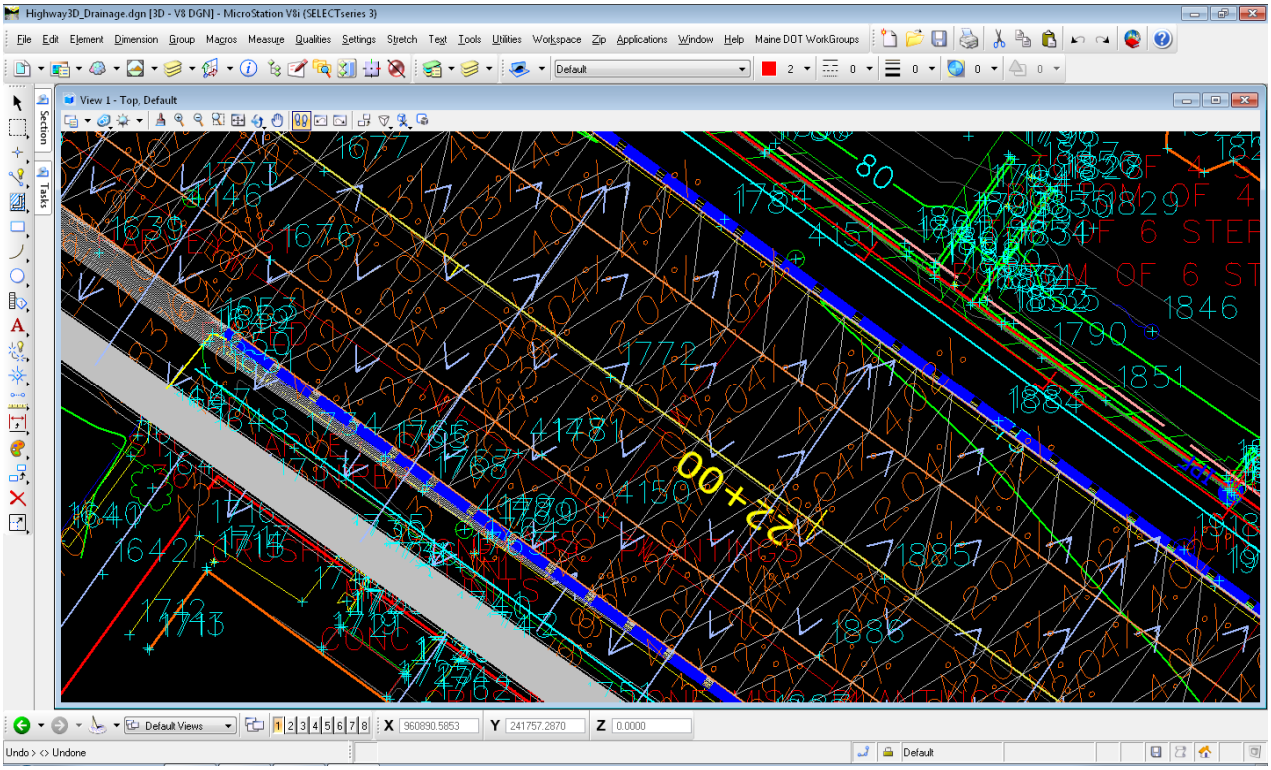
From the **Main** Tab, select the surface, the **Display Mode** as **Grid** with an **Interval** of 10'and deselect **Direction** in **Symbology.**



From the **Advanced** Tab, change the **Vector Scale** to 20



Select **Apply**



Direction of Flow and Slope can be reviewed to determine that Drainage of the Contractors Model meets the Design Intent.

REVIEWING THE CONTRACTOR 3D MODEL FOR RIGHT OF WAY COMPLIANCE

Overview

Now that the Contractor's Model has been imported into an InRoads surface; the Contractors Finish Grade Surface can be displayed and the proposed Right of Way Referenced to confirm that the Contractors Model does not extend outside the State's Right of Way or acquired Rights.

In this example the Contractor's Model does not extend to the Cut/Fill Lines, so this review would not apply.

In instances where omissions are made in the model those omissions must be noted in the Review Evaluation/Approval.

CERTIFYING THE CONTRACTOR 3D MODEL AFTER REVIEW

Overview

Now that the Contractor's Model been reviewed and evaluated against the Contract Plan Set, a written notice needs to be prepared and distributed to the Project Manager and/or Construction Resident.

The notice needs to be signed by the Engineer of Record for the Plans, and should contain:

1. The name, date, and size of the file received from the Contractor for review.
2. Indication that the 3D Model received from the Contractors meets the "Design Intent" of the Project, within the tolerance specified in the Projects Contract documents ; or
3. Indications of each location identified to be out of tolerance.

Ideally, the Contractor's 3D Model will agree with the Contract Plan Set. There can be instances where revision of the is not in the Department's best interest, and the Resident and Inspectors need to know where the Contractors 3D Model cannot be relied upon, and alternative inspection procedures are necessary to assure compliance with the Contract Plan Set.

After distribution, copy of the notice should be placed in the CONST folder for the Project (Y:\pin\).