DIGITAL
Delivery Program

Texas Department of Transportation

Digital Delivery Program

3D Model Breakline Creation Process

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Texas Department of Transportation

This documentation is in draft form and is currently being piloted by TxDOT's Digital Delivery Program. For any questions, comments, or feedback please send to digital-delivery@txdot.gov.

Digital delivery projects require the creation of 3D model breaklines for contractors to generate and import design surfaces into construction and surveying applications. It is important for design teams to thoroughly curate and review 3D model breakline files, and these files must be updated anytime a corridor or model is modified. All 3D model breaklines should be provided to the contractor in a single drawing file. The procedures outlined in this document ensures there are no gaps, overlaps or duplicates in the 3D model breakline file.

The naming convention for 3D model breaklines is crucial to provide consistency and communication between the design intent and construction. Refer to the TxDOT workspace and Template Point Naming Convention for current naming conventions, and as standard naming convention is continued to be developed, consider the following:

- 3D model breaklines for the same design element should maintain consistent level naming and feature definitions (i.e. edge of pavement, HMA, subgrade, etc.)
- Names should be unique between the different layers of material.
- See UDOT's template point naming convention for examples on unique level naming: https://drive.google.com/file/d/19g7UQiekp5EbdN0BOjYyireH2j602JWa/view

Process Overview

1. Develop and refine 3D model.
2. QC all corridor & modeling files.
3. Set corridor, linear template and surface template feature definitions to show linear features.
4. Merge all corridor & modeling files into new 3D model space.
5. Manually cleanup 3D model breaklines.
6. Create terrain models for finished grade and subgrade surfaces.
7. QC terrains and update 3D model breaklines as necessary.
8. Create exterior boundary for 3D model breaklines.

Detailed Process Steps

1. Develop and refine 3D model

a) Developing a 3D model to the fullest design intent within OpenRoads is crucial for accurately representing and communicating every aspect of the design. While some design elements may require further refinement, such as grading or intersections, increasing level of detail within the 3D model improves the quality of model-based delivery and ensures consistency across all design outputs derived from the 3D model.

   i. **TIP: if using surface templates, ensure feature definition is set to “Enable Linear Features” when placed.**

2. QC all corridor & modeling files

a. Ensure all corridor, linear and surface templates avoid vertical faces between points in the subgrade or finished grade surfaces. All point names and feature definitions should follow the TxDOT workspace for naming convention. See TxDOT's Template Point Naming Convention for more information on template naming and TxDOT's QC Checklist for additional review guidance.
   i. **TIP: It is recommended to use linear templates around surface templates with edge conditions (i.e. pavement tapers) to avoid manual offsetting in Step 5.**

3. Set all corridor, linear template, and surface template feature definitions to show linear features

a. Set corridor feature definitions to "5 – Final w/ Breaklines" (see Figure 1)
b. Set linear template feature definitions to "Final" (see Figure 2)
c. Ensure surface template feature definitions to "Enable Linear Features"
   i. If the surface template does not have this feature enabled, delete the surface template and reapply to the terrain model.
d. Close and check-in all corridor and model files to ProjectWise

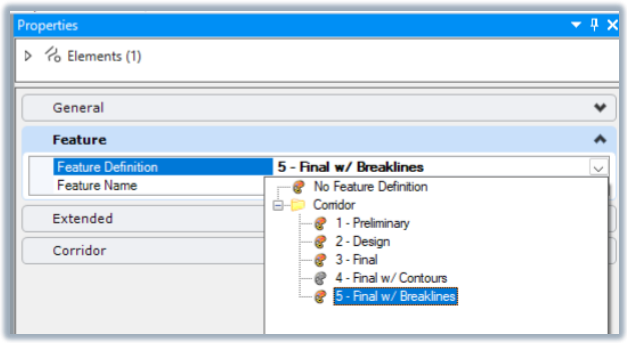

Figure 1 – Setting Corridor Feature Definition

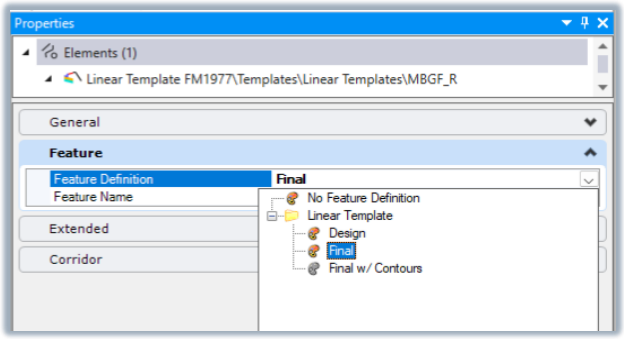

Figure 2 – Setting Linear Template Feature Definition

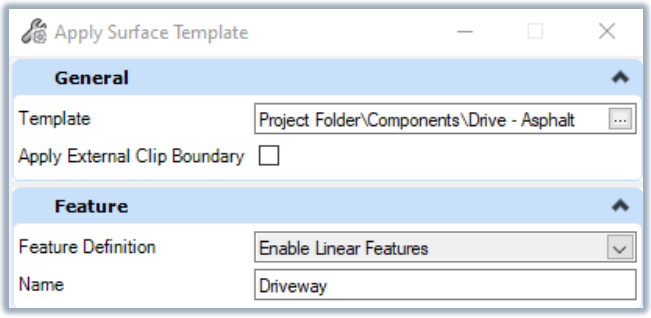

Figure 3 – Setting Surface Template Feature Definition

4. Merge all corridor & modeling files into new 3D model space

a. Create a new file using the project's 3D seed file. Name file in accordance with TxDOT's File Naming Convention.
b. Reference the 3D model space of all corridor and model files. Do not include any 2D references or 3D cells.
c. Filter all unnecessary construction lines, working lines and surfaces that do not represent design intent.
d. Use the "Merge into Master" command from the reference menu to merge all corridor and model files into the 3D model breaklines file.
    i. The "File Fence" command can also be used to complete this step.
    ii. **Note: The coordinate system must be assigned to the new file if using this method.**

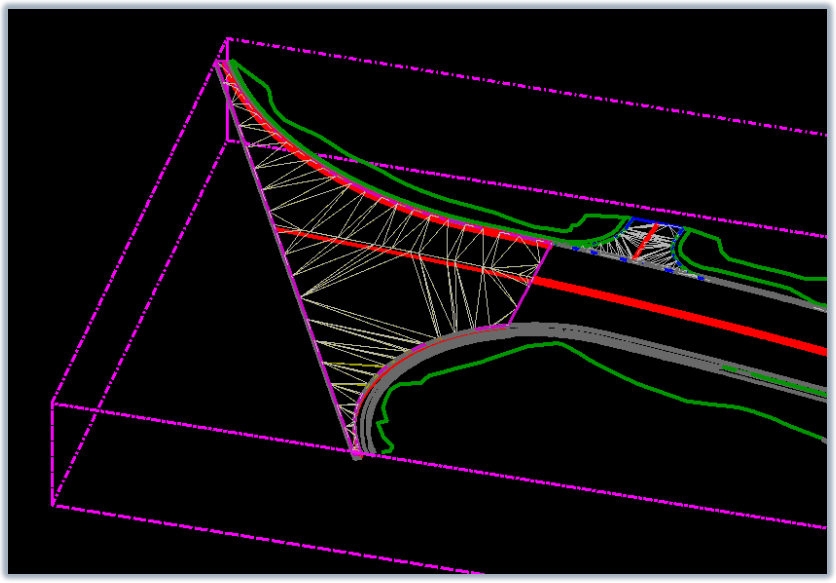

Figure 3 – Attach all corridor and model files to blank 3D model breakline file

5. Manually cleanup 3D model breaklines

As mentioned in Step 1, it is imperative to represent the design intent as accurately as possible within the 3D model. In some cases, variances such as gaps or overlaps may still occur and require a manual approach to 3D model breakline cleanup. This step allows for smooth terrain-model creation and a usable set of 3D model breaklines for down-stream users to create surfaces in construction and surveying applications.

a. Select all 3D model breaklines and use the “Drop Complex Status” command. Breaklines created as complex chains from the template drop (e.g., cut and fill lines) must be dropped for modification. Ensure to connect the cut and fill lines to close any gaps.
b. If linear templates were used, delete 3D meshes and leave 3D model breaklines that represent the design intent.
c. If surface templates were used, delete the 3D meshes while keeping the 3D model breaklines that represent the design intent. If the surface template feature definition was set to “Enable Linear Features”, retain these 3D model breaklines except for those on the top layer. For the top layer, manual placement of the 3D model breaklines may be necessary by tracing the surface template, such as for the centerlines of a side street near an intersection.
d. Since surface templates create vertical faces, manually offset the 3D model breaklines beneath the top surface to accurately represent the design intent. No two lines should be sharing the exact same horizontal space. If modeling pavement structure around a curb return, linear templates can also be used to communicate proper design intent. See Figure 5 and Figure 6.
    a. **Tip: for manually offsetting vertical faces within OpenRoads Designer, rotate to the top view and use the Copy Parallel function.**

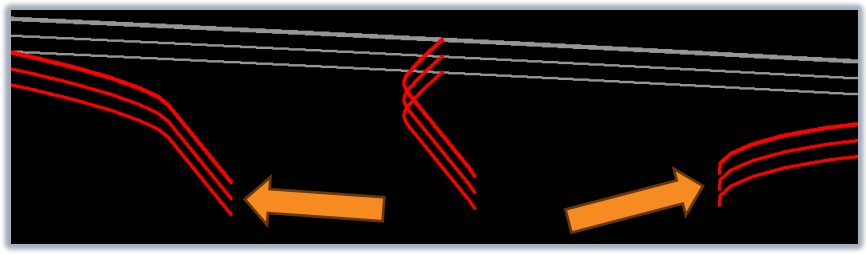

Figure 5 – Veritcal 3D model breaklines along surface template perimeter

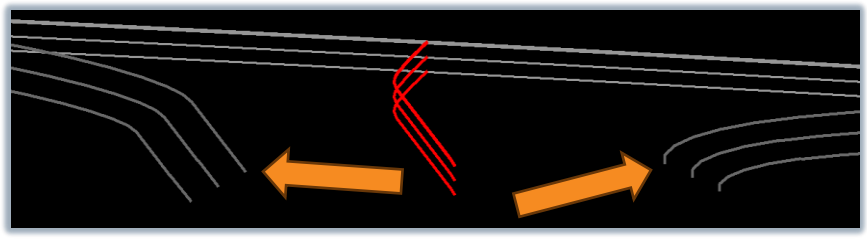

Figure 6 – 3D model breaklines from linear template around curb return

e. Delete any duplicate lines where linear and surface templates meet other corridors. If there is confusion on which line to delete, refer to the project's 3D model breakline naming detail that details the design intent of each 3D model breakline.
f. Trim, extend, or connect any lines that have unintended overlaps or gaps. The "Modify Element" command is often the most effective way to connect two lines, as trimming may only align the lines in two directions based on the current OpenRoads view. Ensure that any modified lines still represent the design intent. Pay special attention to the following areas:
    i. Check 3D model breakline connection where two corridors or template drops meet.
    ii. Connect cut and fill or other toe of slope lines into a continuous line.
    iii. Check intersections, driveways, or areas where complex or multiple models were used. See Figure 7.
    iv. Note: where a corridor's template drop terminates, this gap does not need to be closed. See Figure 8.
g. Verify that 3D model breaklines intended for the same surface do not overlap vertically. If necessary, manually offset subgrade lines to avoid vertically coincident lines, particularly in areas where a surface template was used as mentioned in Step 5.d.
h. Ensure that all level names are consistent with TxDOT's Template Point Naming Convention and communicate features within the template, finished grade, and subgrade.

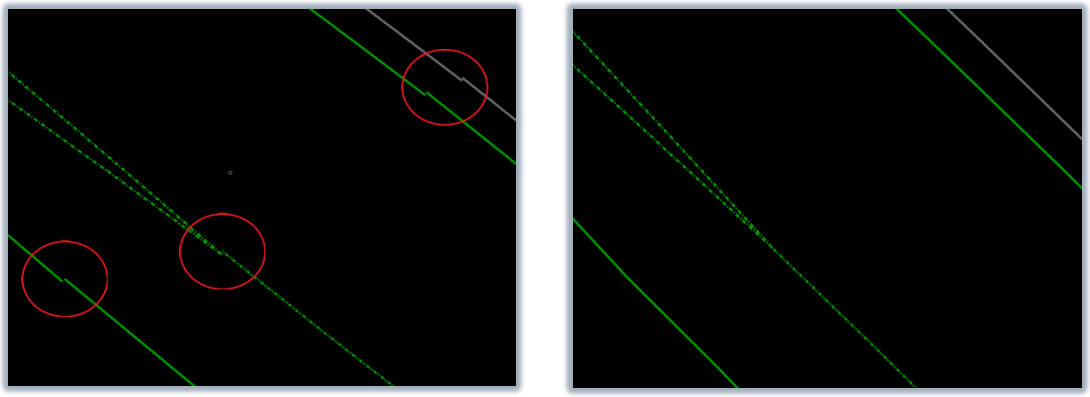

Figure 7 – Before and after trimming 3D model breaklines where a corridor and linear template intersect

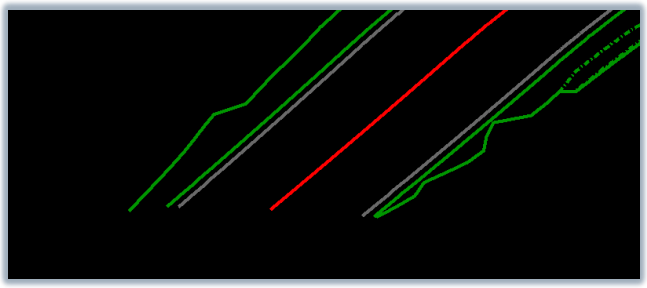

Figure 8 – End of a corridor's template drop

6. Create terrains for finished grade and subgrade surfaces

a. The finished grade surface should encompass all 3D model breaklines representing the finished grade. Similarly, the subgrade surface should encompass all 3D model breaklines representing the subgrade.
    a. If subgrade terrains are overlapping (i.e pavement edge condition under sidewalk), separate terrains can be created for each design feature such as pavement bottom, sidewalk bottom, etc.)
b. Filter and select all elements on the desired levels. Use the “Create terrain model from elements” tool with the feature option set to “Break Line” to generate a terrain model for the desired surfaces. Set the Edge Option to either “Remove Slivers” or “Max Triangle Length”. If choosing “Max Triangle Length”, begin with a 100-foot length and adjust as needed.
c. Graphical filters can also be utilized to create terrains. See Bentley’s guidance on how to properly set up and use this function within OpenRoads.

7. QC terrains and update 3D model breaklines as necessary

a. Review the terrains for any anomalies or errors.
    i. **Note: any triangles displayed in OpenRoads at this stage will likely appear when 3D model breaklines are imported into other software programs, such as AutoCAD or Trimble Business Center.**
    ii. If a pavement section or other element is intended to have a specific 3D model breakline or grade break, ensure the correct 3D model breakline is present and accurately conveys the design intent.
b. Remove extra triangles around curb returns or other curves. The options in the “Edit Model” tool can be used to manually remove edge triangles.
    i. **Note: the rules on the terrain model will need to be deactivated to allow the terrain to be editable.**
c. Utilize the Report crossing Features and Report Conflicting Points tools to check the terrains for conflicts.
d. Update 3D model breaklines if issues are found and recreate terrains.

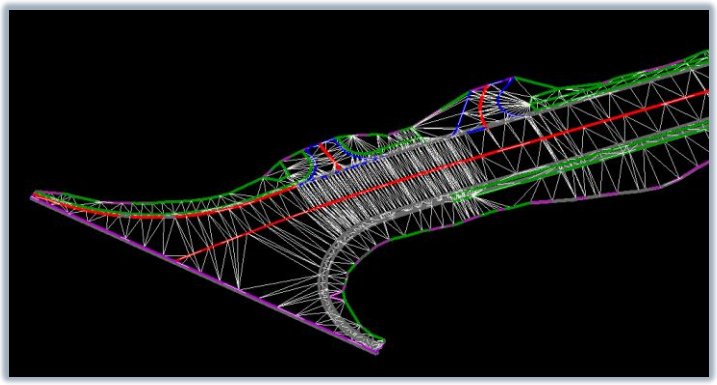

Figure 9 – Finished grade terrain with triangulation

8. Create exterior boundary for 3D model breaklines

a. Create a continuous shape that extends around the extents of the terrain. This can be used to define the outer limit of the finished grade and subgrade surfaces. This boundary should be used as a boundary only and excluded from triangulation.
   i. Use the Boundary Options -> Add Boundary tool in the Edit section of the Terrain tab of the OpenRoads Modeling workflow. Set the method to “Extract Graphic”, set the feature definition to “Terrain Exterior” and select the terrain. This will create an editable 3D linestring and preserve the terrain model. See Figure 10.

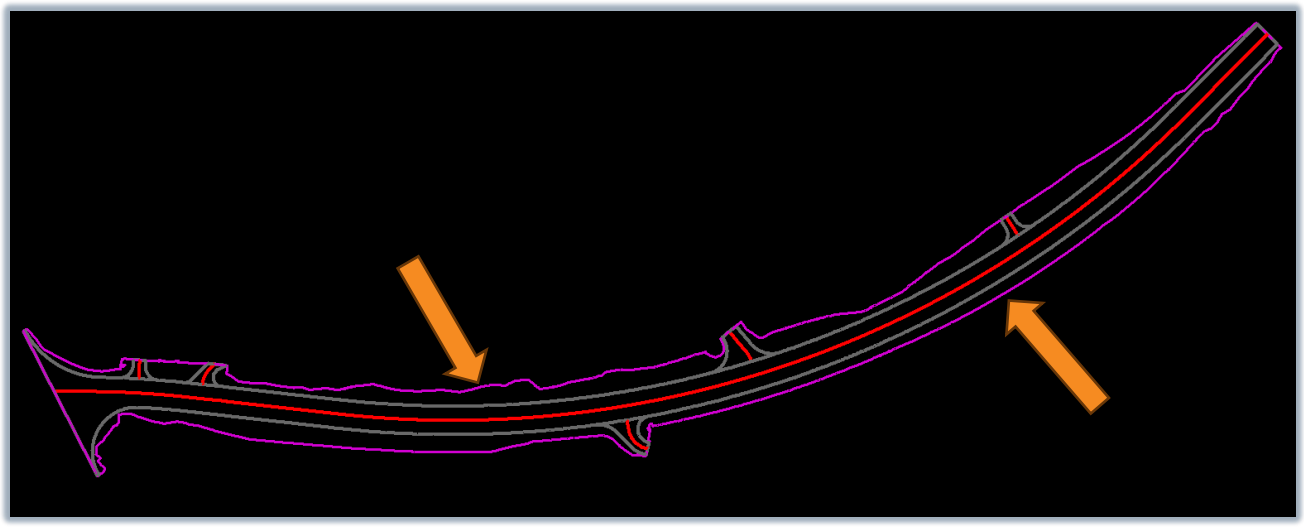

Figure 10 – Finished grade terrain boundary