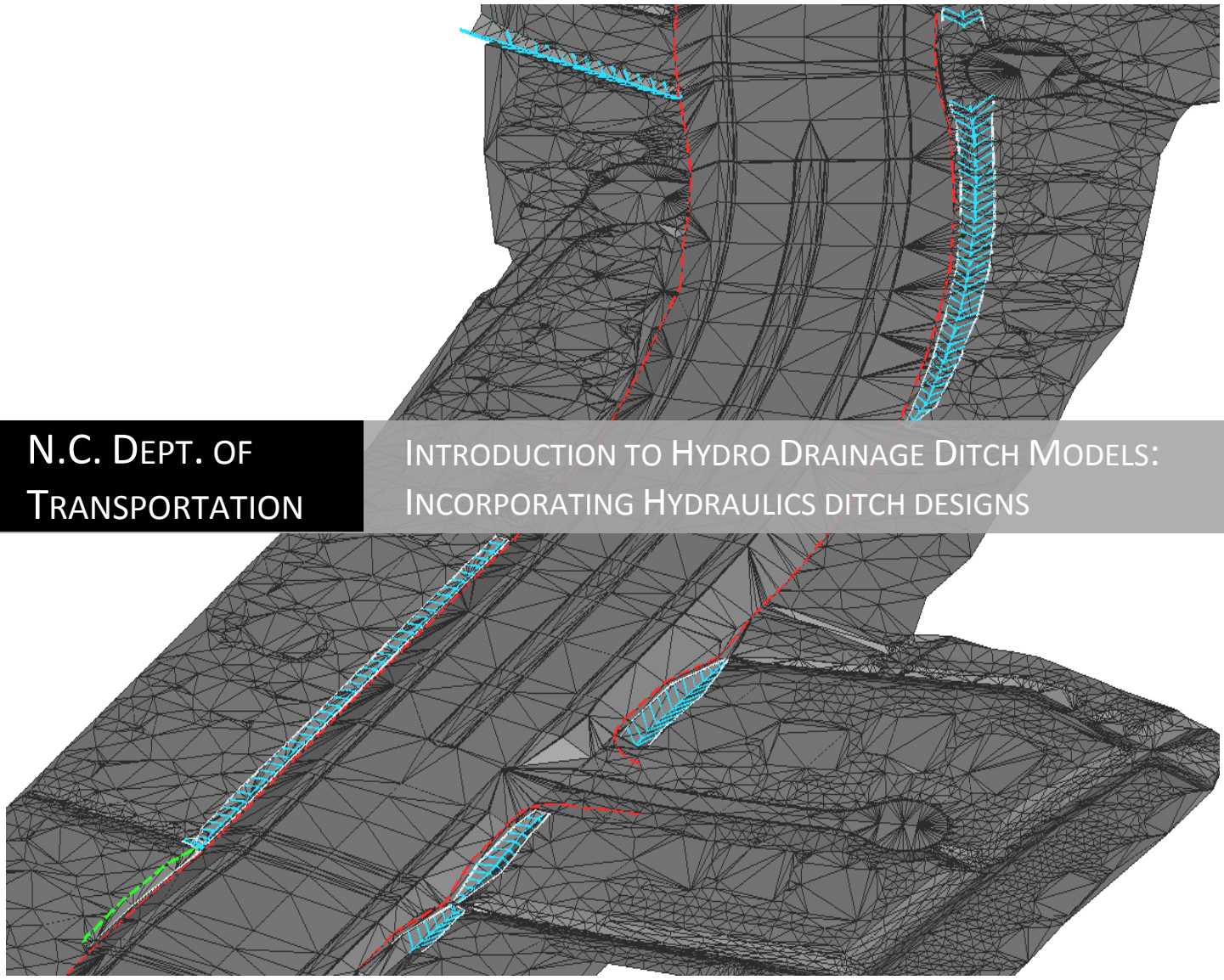
July 21, 2015



N.C. DEPT. OF TRANSPORTATION

INTRODUCTION TO HYDRO DRAINAGE DITCH MODELS: INCORPORATING HYDRAULICS DITCH DESIGNS

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The NCDOT OpenRoads Technology Delta Training Series should be used as guide to aid the completion of NCDOT TIP Projects. As technology and standards change, we will do our best to update the training manuals. However there will be a point in time when this manual will no longer be able to be updated and a new set of training manuals will be warranted.

Contact Information:

Oak Thammavong
Assistant Project Design Engineer
NCDOT Roadway Design Unit (Web Page)
1000 Birch Ridge Dr. (Show on Google Maps)
Raleigh, NC 27610
(919) 707-6200 (office)
(919) 707-6327 (direct)
(919) 250-4036 (fax)
sothammavong@ncdot.gov

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Hydraulics Ditch Design Modeling Overview

A lot of time, effort, and innovations have been put forth in coming up with a better way to incorporate Hydro ditch models into Roadway plans. It is not an industry standard, but what works best in our workflow. Some processes were "rigged" to be effective, as will be explained in the following exercises.

There are three general classifications of hydraulics drainage ditches; head and tail ditches (HAT), lateral ditches (LAD), and roadway ditches (ROD). For each ditch type, it is important to locate the ditch origin point in the template, usually the template origin point. Both HAT ditches and LAD's can use a 2D plan graphic feature (X, Y) as the ditch origin, usually the slope stake limits. Since ROD's may require modifications starting from the roadway shoulder point, a 3D linear feature (X, Y, Z) contained in the proposed DTM can be used as the ditch origin. The key is how to obtain Roadway DTM features in a Hydraulics working environment. The Corridor Modeling files and folders must be kept separated, but referenced and linked to each other to maintain the dynamic link of OpenRoads Technology.

Files and Folders Structure – Separated but Linked

Ditch models should be created in a separate folder than the standard Roadway\CorridorModeling folder. A **Hydro_CMD** sub-folder (under the main Roadway CorridorModeling folder) is recommended for Roadway engineers. For Hydraulics engineers a **Hydro_CMD** folder can be created in the Hydraulics\CADD folder.

This separate folder structure is necessary so the existing (THY) corridor modeling files are not overwritten by Hydro drainage ditch models. The resource files are not conflicting with each other to avoid file corruption. Even though the Corridor Modeling files are separated, they can be referenced to each other to maintain the dynamic link.

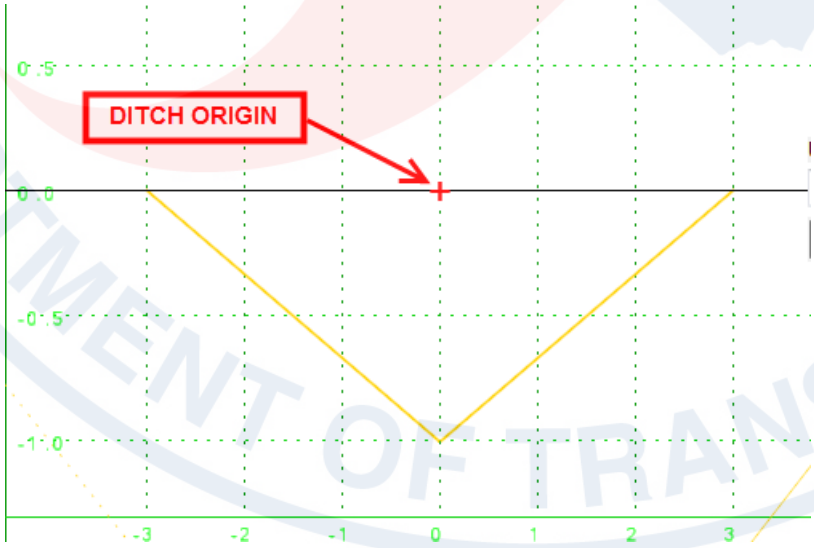
Head and Tail Ditches (HAT)

HAT ditches differ from other ditch types by the way the water is designed to flow. They do not necessary have to follow the roadway horizontal alignment laterally. HAT ditches are usually not drawn in the cross sections. However, their limits and boundaries are plotted in plan view (for right of way easements), DDE quantities are computed, and modeled as part of the grading surface.

Head or Tail

- Head ditches are usually located at pipe inlet.
- Tail ditches are usually located at pipe outlets.
- Head and tail ditches sometime connect two pipes in a system.

Ditch Origin



Working Folder and Files

Folder:
C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Hydro_CMD

Active File:
U4751_HYD_CMD_2D.DGN

RDP:
N/A (create new)

ITL:
U4751_HYD.ITL

GPK:
HYD

IRD:
N/A (create new)

Plan Sheet:
U4751_HYD_PSH_S11.PDF

Profile Sheet:
U4751_HYD_PSH_S38-PFL.PDF

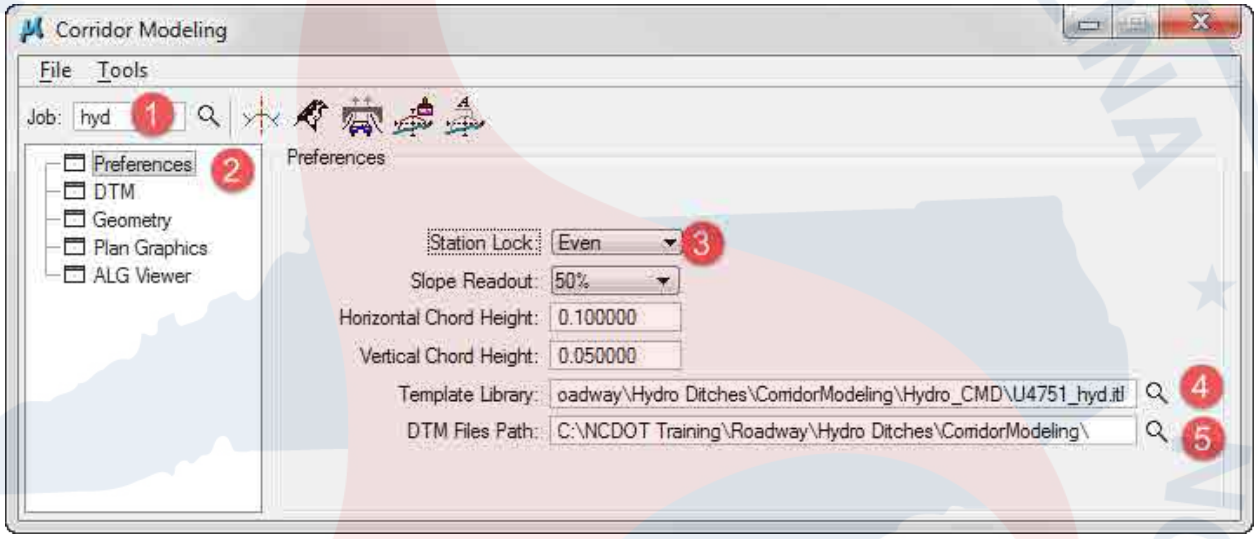
Corridor Modeling – Initial Setup

Preferences

1. In the **Corridor Modeling** dialog box, load the HYD GPK.

2. In the **Preferences** tab, set the **Station Lock** to *Even* and the **Template Library** location to:
C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Hydro_CMD\U4751_hyd.itl

3. Set the **DTM Files Path** to:
C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling



Note in step 3, the **DTM Files Path** is set to the Roadway Corridor Modeling folder. This configuration has two very important ramifications:

1. No re-import of the existing ground TIN. Use the existing ground DTM Roadway has already converted.

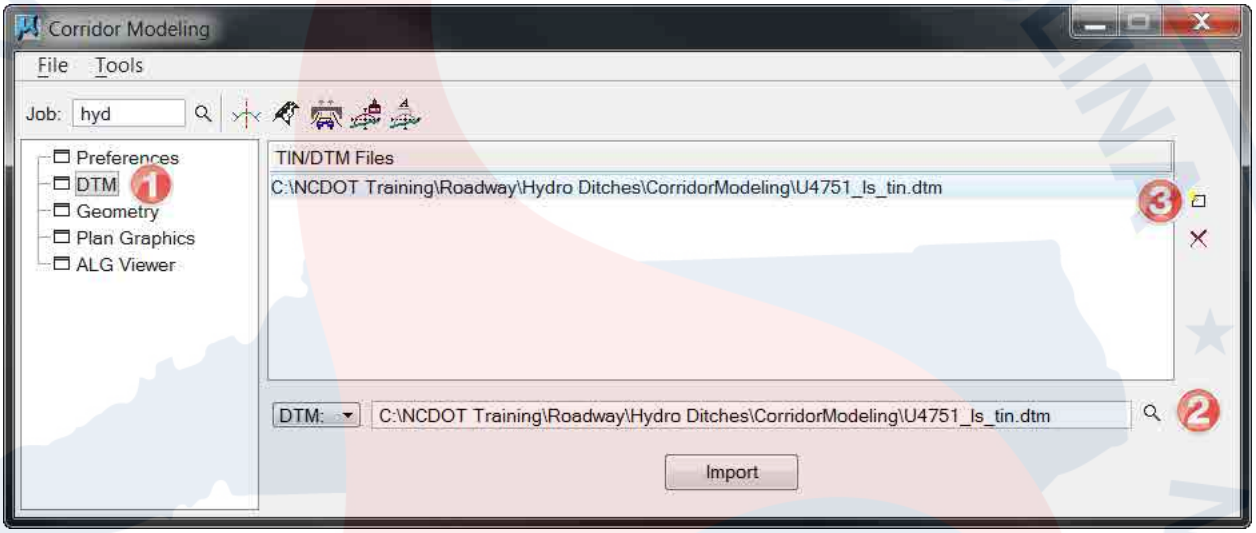
2. Gain access to critical 3D linear feature information of the proposed roadway DTM, such as the shoulder point and slope stakes X, Y, Z location.

4. **Save as** U4751_HYD.RDP.

DTM

5. In the **DTM** tab, select the **DTM** location:
C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\U4751_ls_tin.dtm

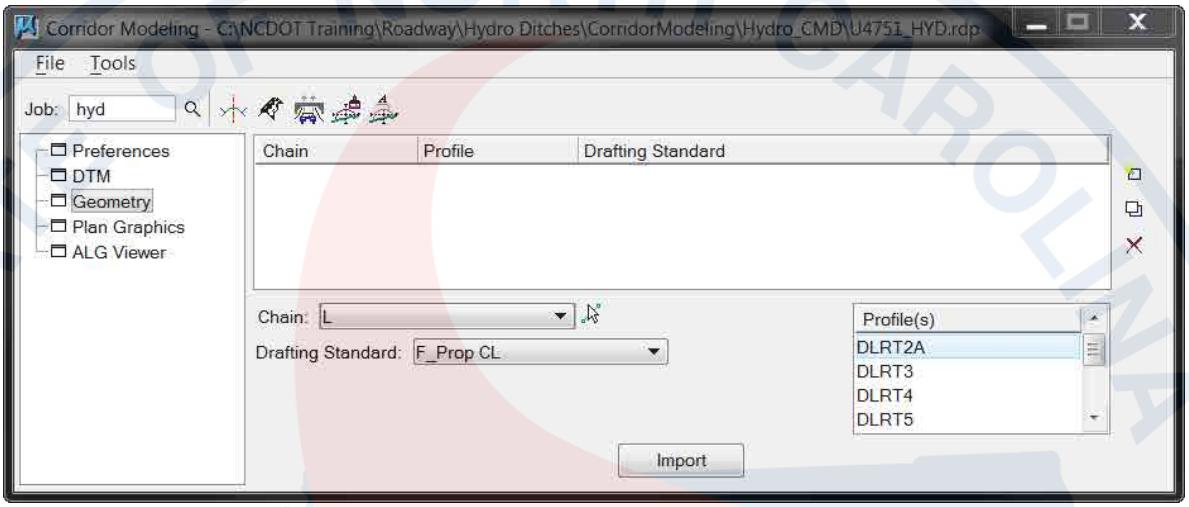
6. **Add** the selected DTM to the list. Note no re-import of the existing ground DTM is necessary since Roadway has already converted the existing ground TIN to DTM.



7. **Save** the RDP file.

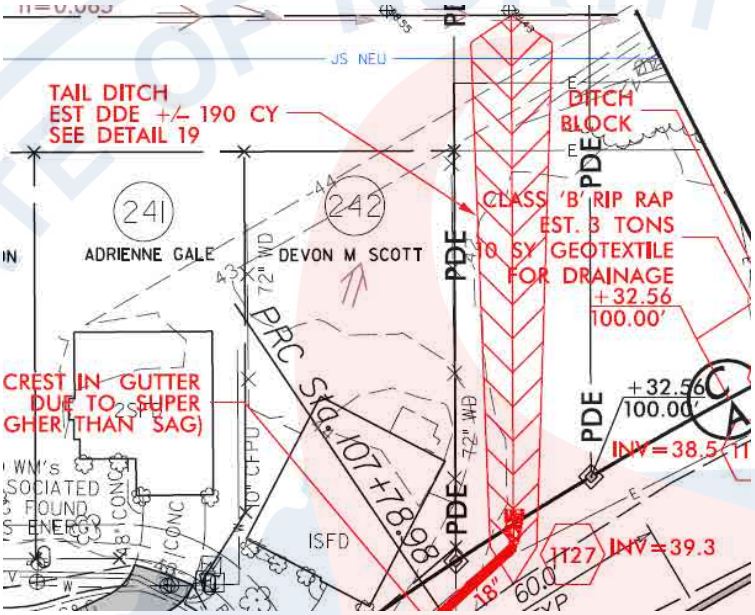
Geometry

8. For HAT ditches, no Geometry/GPK information is needed. Therefore the **Geometry** tab list can be left blank.

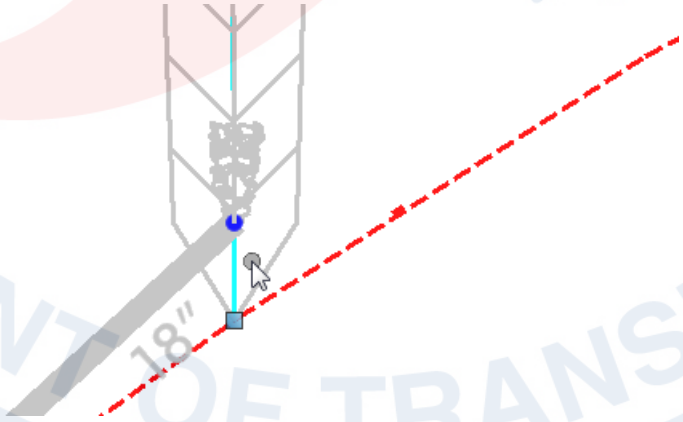


Plan Graphics - LT_L-HAT_108+00

9. Near the top right corner of plan **sheet 11** (U4751_HYD_PSH_S11.PDF), there is a proposed tail ditch. Draw a line on **Scratch_Level_0** from point #1 to #2 in 2D DGN file indicating the desired centerline location of the tail ditch.

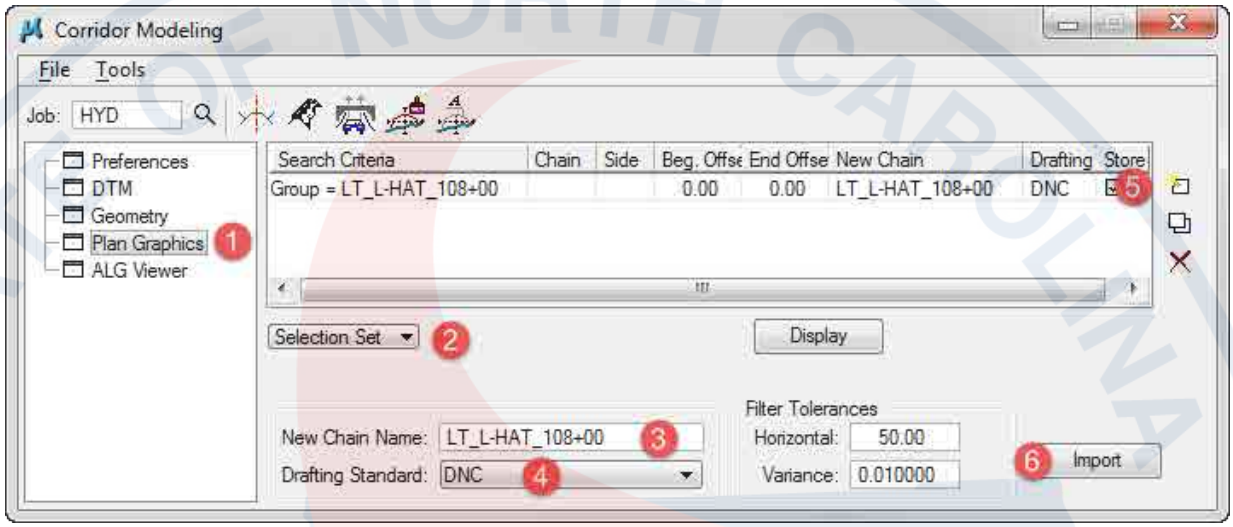


10. Select ditch centerline in the DGN. **Note stationing depends on how the centerline was drawn and its direction. 0+00 begins at the start point.**



11. In the **Plan Graphics** tab, use **Selection Set** to store the centerline ditch location of the tail ditch with the following settings:

New Chain Name: LT_L-HAT_108+00
Drafting Standard: DNC



Standard Ditch Naming Convention (HAT)

Standard ditch naming convention should be *LOC_CHA-HAT_BEG STA.*

RT_L-HAT_097+83
LT_Y8-HAT_12+86
LT_RPA-HAT_18+65

---

12. Uncheck the box under the **Store** column.

13. De-select the HAT plan graphics (data point anywhere on the screen).

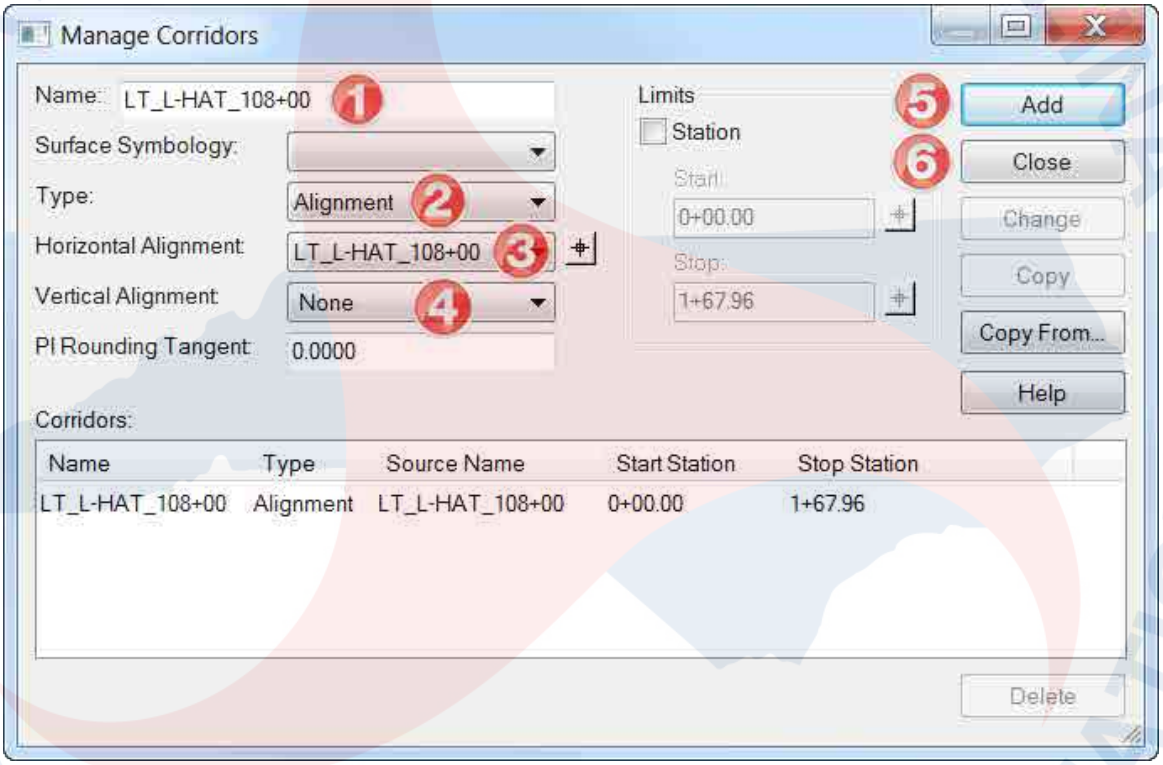
14. **Save** the RDP file.

Roadway Designer – LT_L-HAT_108+00

Managed Corridors – Create New Ditch Corridor

1. In the Roadway Designer Managed Corridors dialog box, create a new corridor with the following settings:

Name: LT_L-HAT_108+00
Type: Alignment
Horizontal Alignment: LT_L-HAT_108+00
Vertical Alignment: None



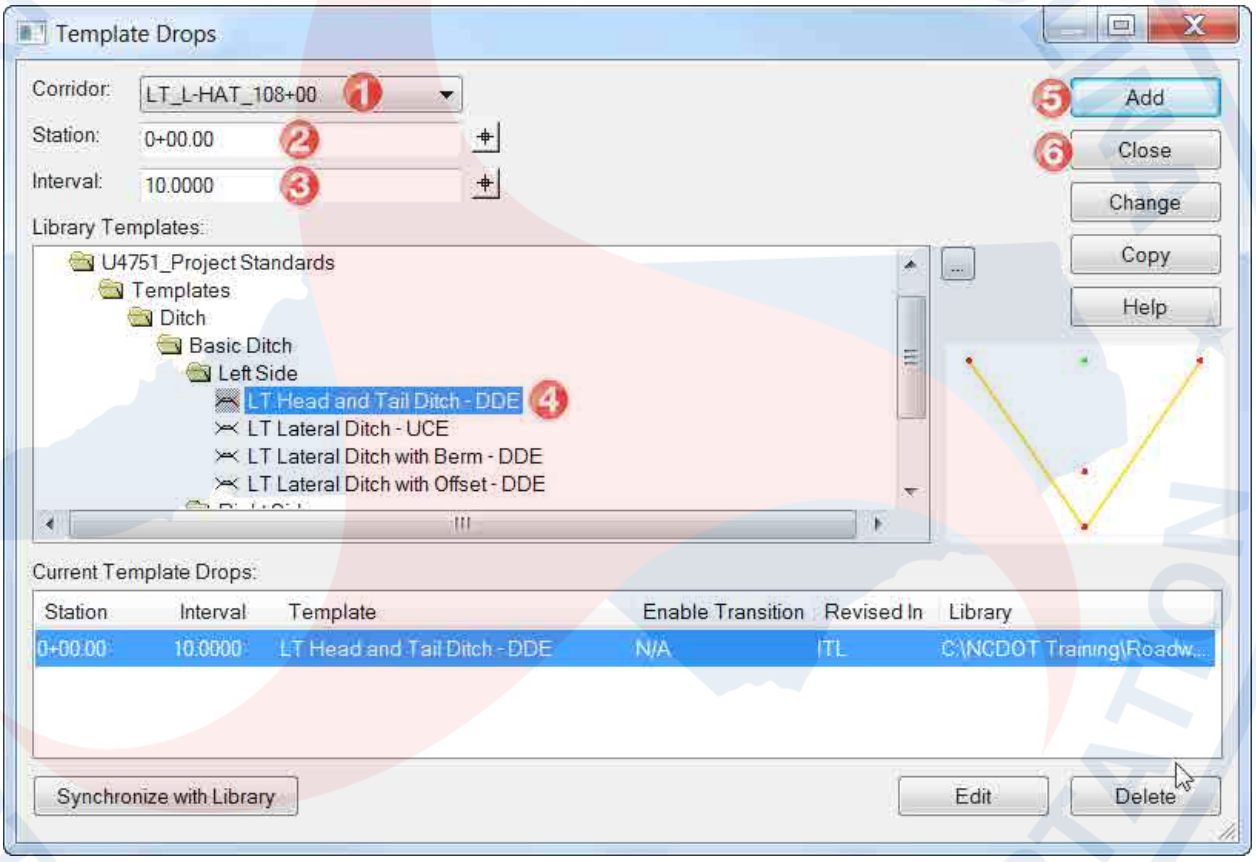
2. **Save as** U4751_HYD.IRD.

If the existing profile is available, choose it as the **Vertical Alignmen**t. This will put the template null points “close” to the ditch components, instead of elevation 0’.

Template Drops – Corridor Template Selection

3. In the **Roadway Designer Template Drops** dialog box, add the following template drop and settings:

Corridor: LT_L-HAT_108+00
Station: 0+00.00
Interval: 10
Library Templates: LT Head and Tail Ditch – DDE



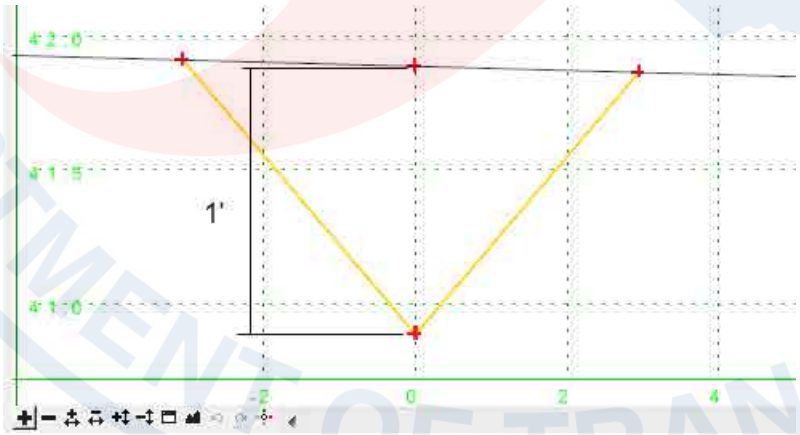
4. **Save** the IRD file.

Default Ditch Slopes

Default ditch slopes are 2:1. Since this project is located east of I-95, the steepest allowable slope is 3:1. The parametric constraints were changed at the template level, instead of while in Roadway Designer, to save time.

Default Ditch Depth

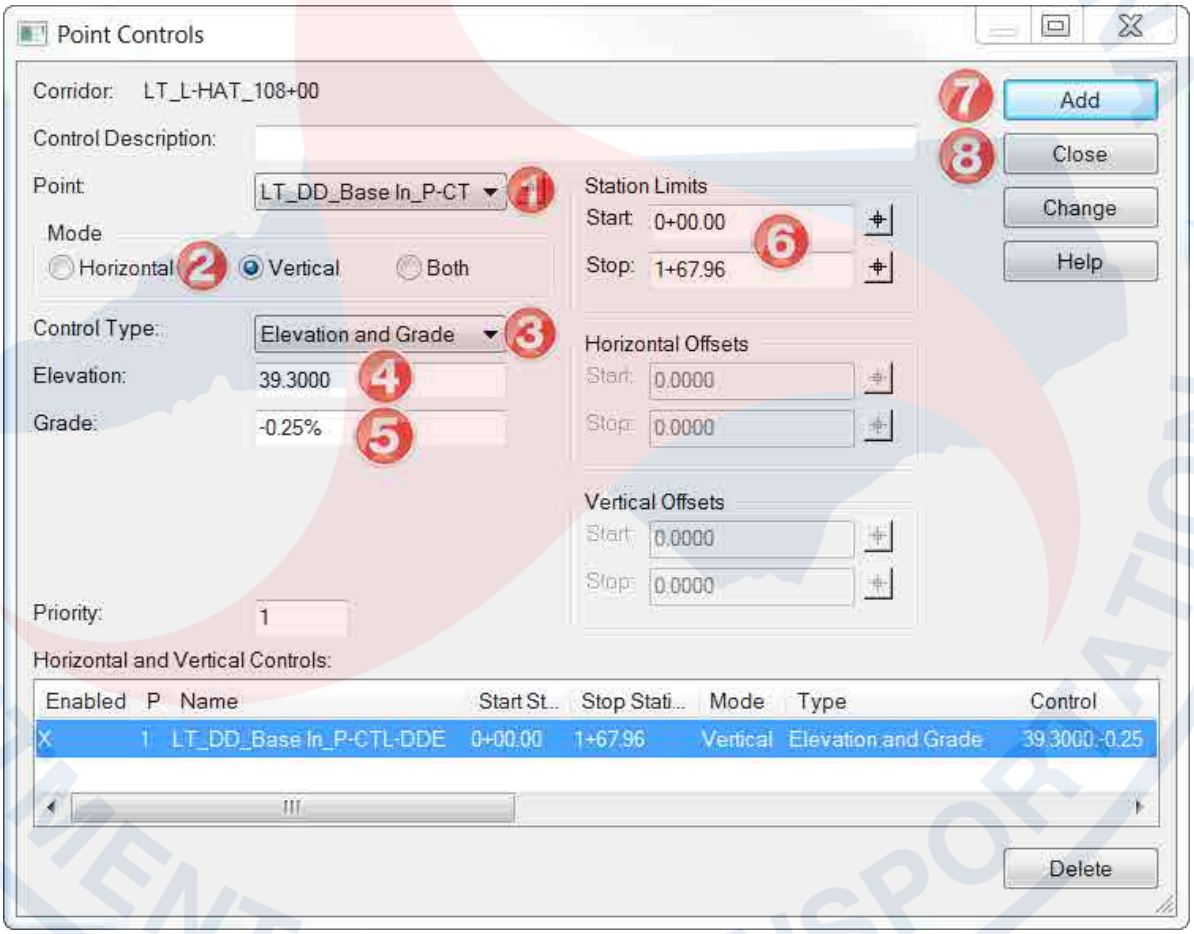
Default ditch depth is 1’ O.C.



Point Controls – for Ditch Grade

5. In the **Roadway Designer Point Controls** dialog box, add the following point control settings to determine the ditch grade **(point control is for the entire length of the corridor – start/stop station)**:

Point: LT_DD_Base In_P-CTL-DDE
Mode: Vertical
Control Type: Elevation and Grade
Elevation: 39.30 (invert elevation from plan sheet)
Grade: -0.25% (arbitrary/downstream)



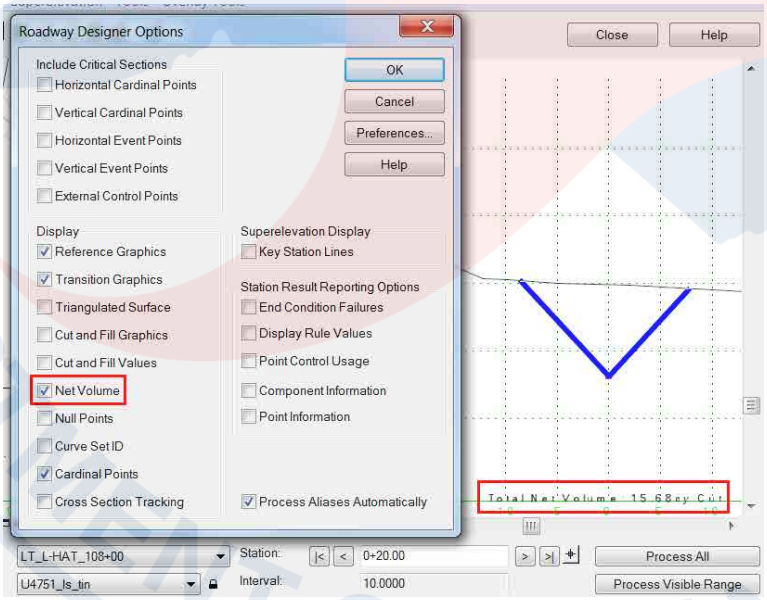
6. **Save** the IRD file.

Increasing Grade Decimal Places

Often it is common to increase the grade percentage readout to four decimal places. This is accomplished through the **Geopak User Preference**s under **Angle Seconds.** It is also common practice to compute an odd ditch grade (0.1234%) using two known elevations set to two decimal places (12.34').

Quick DDE Quantity

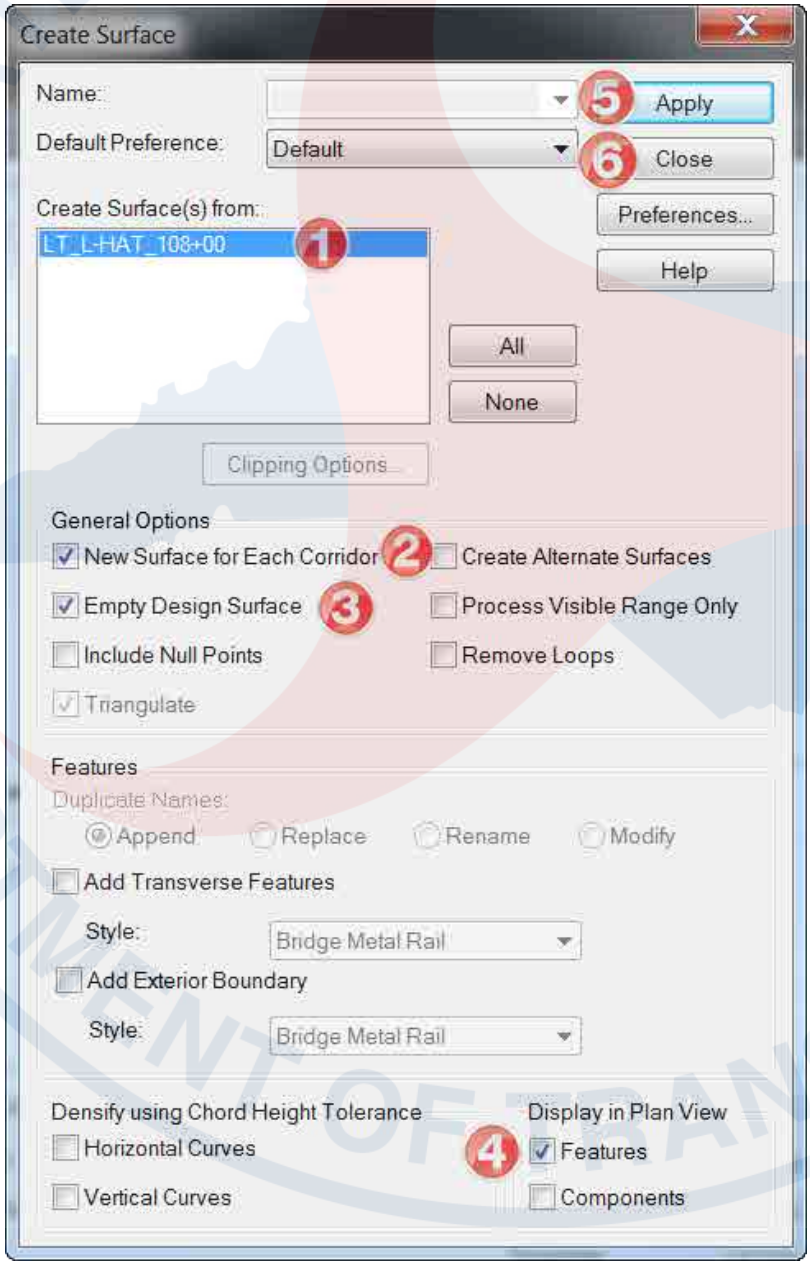
For a quick drainage ditch excavation (DDE) quantity report, check **Net Volume** in the Roadway Designer Options dialog box (**Tools → Options**). Scroll through the sections and the accumulated DDE volume is displayed at the bottom of the cross section view.



7. **Process All** sections in Roadway Designer.

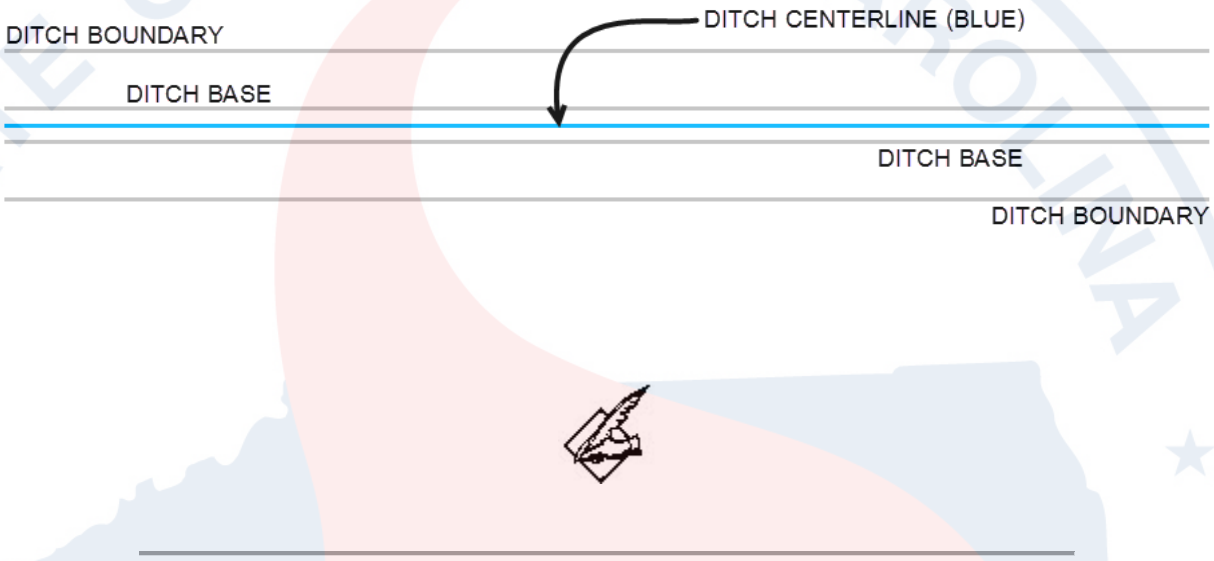
8. In the **Roadway Designer Create Surface** dialog box, create the proposed ditch DTM/TIN with the following settings:

New Surface for Each Corridor (on)
Empty Design Surface (on)
Features (on)



Ditch Drafting in 2D Plan View DGN File - LT_L-HAT_108+00

When ditches are laid-out initially through Corridor Modeling, pair of ditch boundary and base lines are automatically generated. The blue ditch centerline is also created as features. The two base ditch lines can be turned off to making the ditch centerline selection for patterning more easily and avoiding confusion.

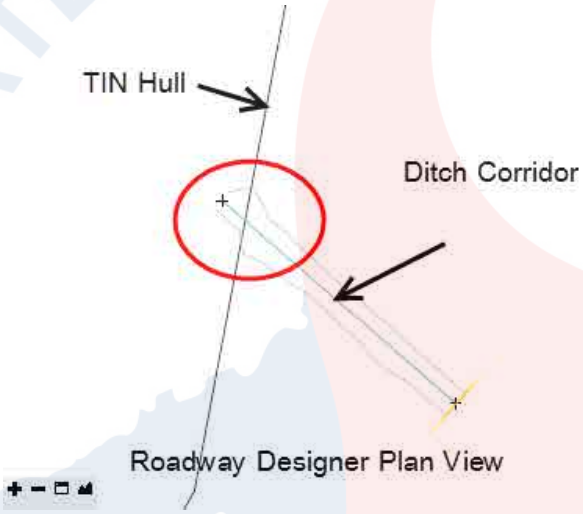


Default 'V' Ditch with a 0.01' Base

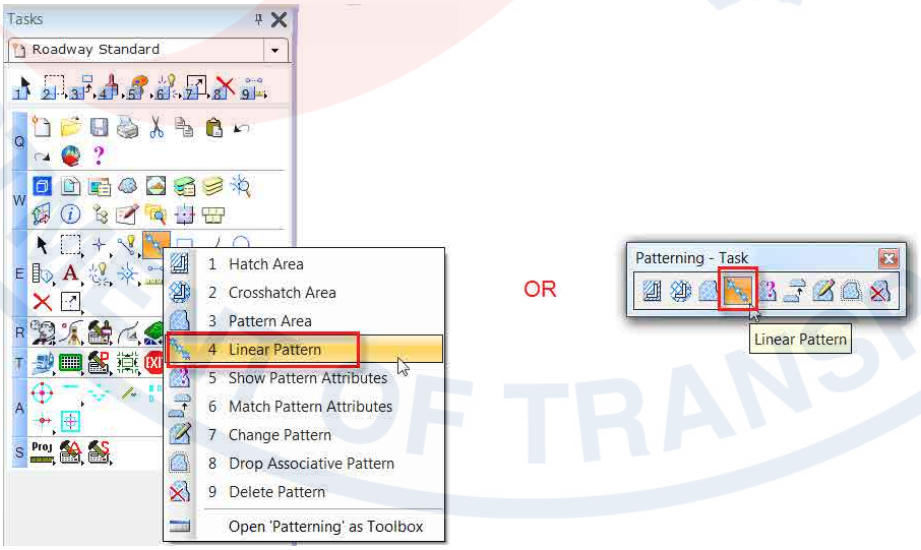
Note all ditch templates are configured to be base ditches by default. Even a 'V' ditch will have a 0.01' base width. Parametric constraints can be used to change the ditch base to a desired width. This was done to have a consistent point name convention for cross section labeling.

Existing Terrain Model Coverage

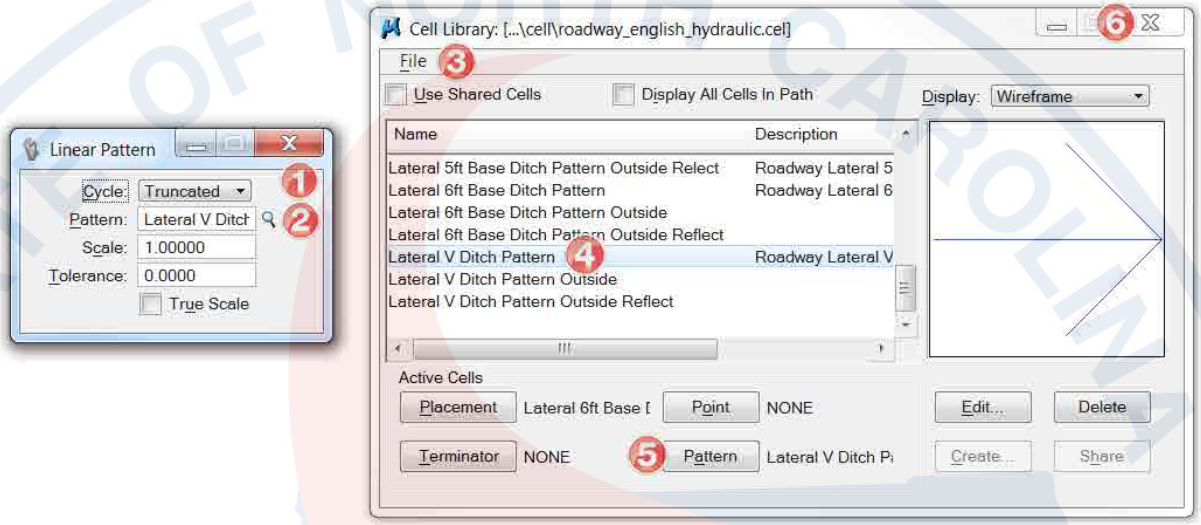
Note the ditch starts to become inconsistent near the end. This is due to not enough coverage in the existing ground TIN/DTM. The ditch corridor has exceeded the coverage of the existing terrain model.



1. In Microstation, from the Roadway Standard Task Tools, select the **Linear Pattern** toolbox.



2. In the **Linear Pattern** dialog box, set the **Cycle** option to **Truncated** and browse for the cell **Lateral V Ditch Pattern** found in the **roadway_english_hydraulic.cel** library and select it as the cell to be patterned.

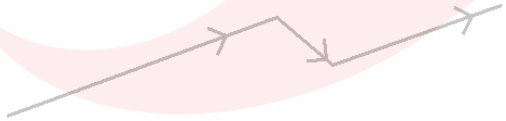


Linear Pattern - Cycle Options

Truncated – unadjusted active pattern scale resulting in the last instance of the pattern for the cycle sometime placed truncated or partially completed.

Complete – adjusted active pattern scale resulting in all patterns for the cycle placed as complete patterns.

Single – place one pattern for each segment of the cycle. Each segment can be a singular element segment such as a line, arc, curve, or ellipse or a combination of elements such as each segment in a line string, complex chain, or smartline element.



Multiple – adjusted active pattern scale resulting in the placement of complete patterns for each segment of the cycle.

Truncated vs. Complete vs. Multiple Cycle Option Recommendation

Even though **Truncated**, **Complete**, and **Multiple** cycle options are similar in many ways, it is recommended **Truncated** be used as the standard practice because of its uniformity and the consistency it produces when comparing it to the other ditch systems of the entire project. With **Truncated**, no adjustment is made to the active pattern scale. Therefore no adjustments to the pattern cell size and spacing are made.

If the Designer chooses either **Complete** or **Multiple**, please be consistent throughout the project.

Chevrons as a Civil Cell

Future versions of the software may eliminate the need for Linear Patterns and ditch pattern cells. The new OpenRoads Technology has a **Civil Cell** feature which may help automate the process.

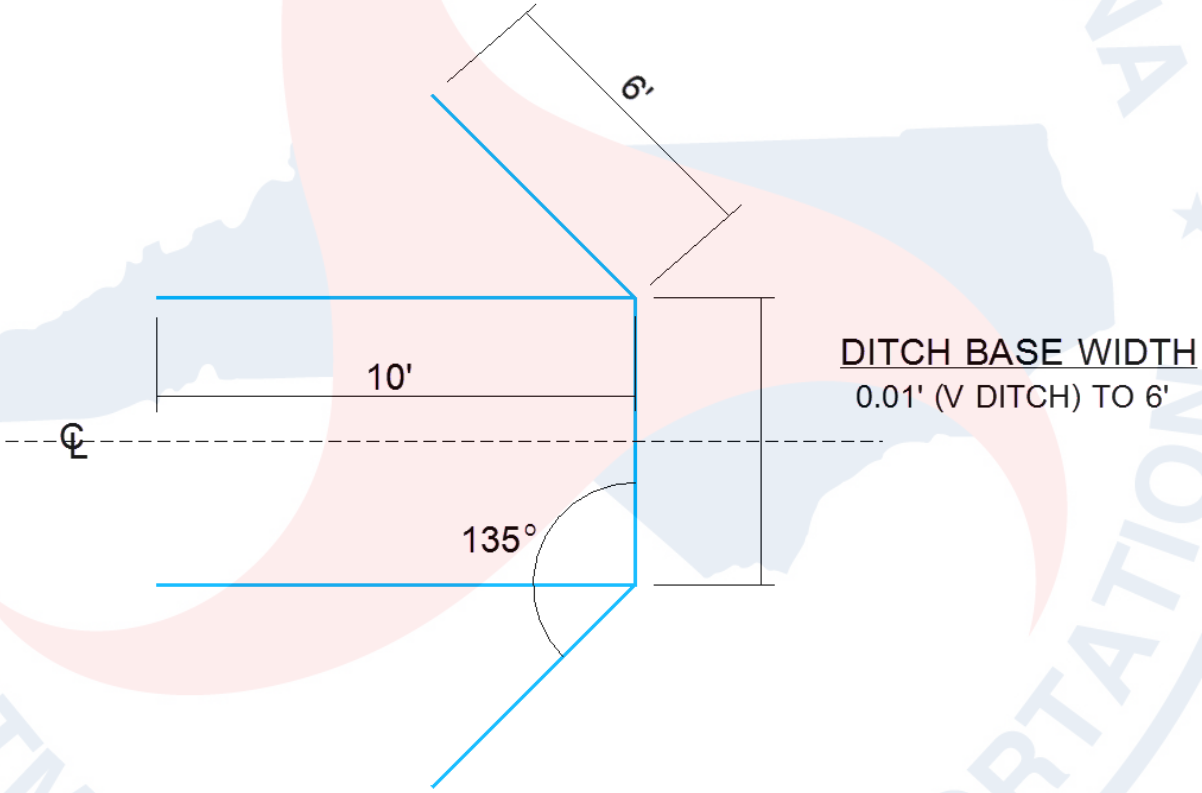
Linear Pattern Cells not Snappable

By default linear pattern cells are not snappable. There used to be a user command (uc=snap?) to make linear pattern cells snappable, but it no longer exist. Making an individual element snappable/non-snappable can be set through the element properties dialog box. Future versions of Microstation may fix this issue or a custom VBA can be created to make completing the task easier.

Linear Pattern – Roadway Ditch Pattern Cells

Roadway ditch pattern cells represent the contours of a ditch system. Often referred to as “chevrons”, they “point” in the opposite direction of the way the water is designed to flow.

The base Roadway ditch pattern cells are drawn symmetrically with the same dimension, the difference being the various base widths. Notice each ditch pattern cell has a 10’ base line. This is important in determining the spacing and cycle of the chevron patterns.



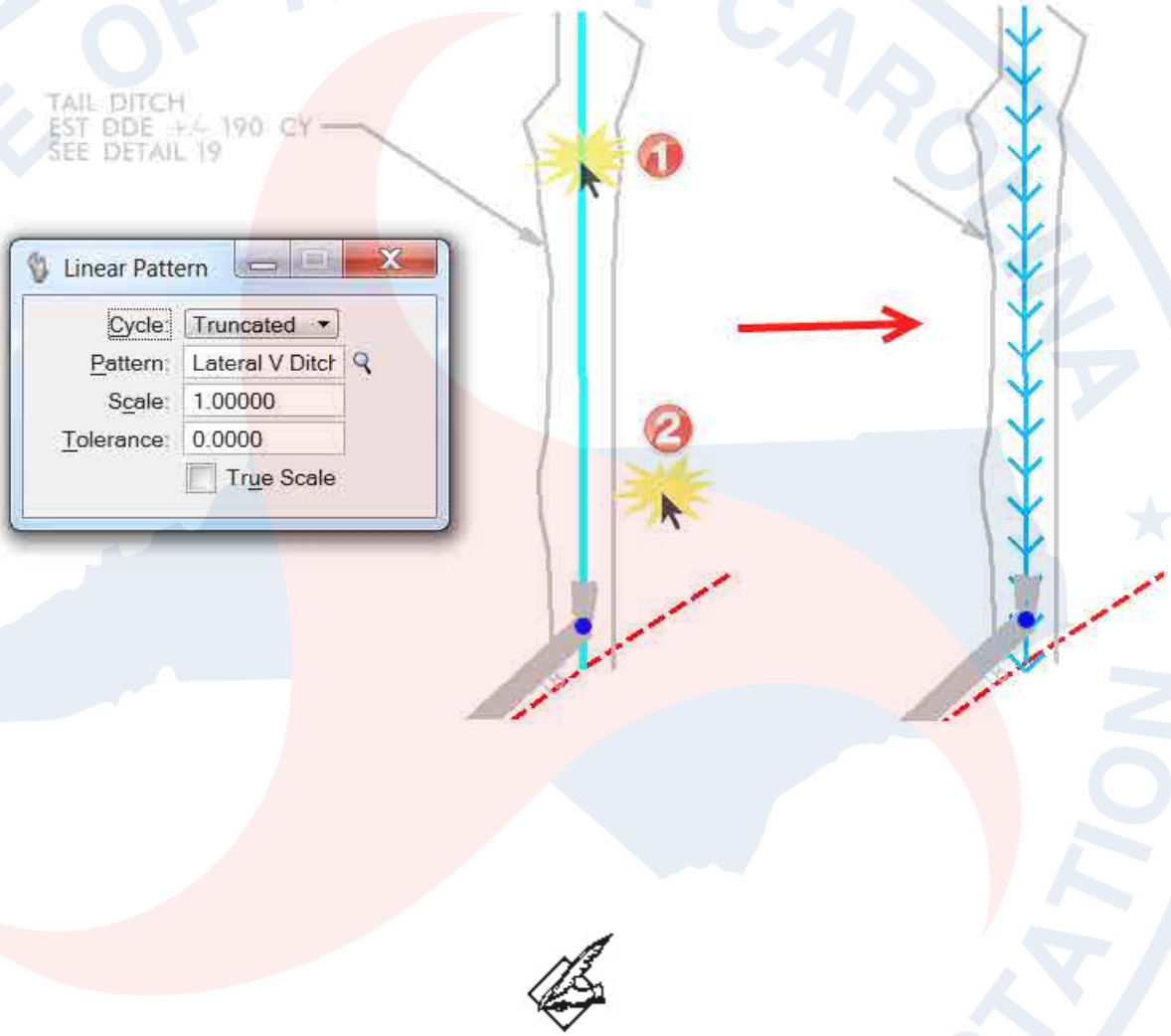
Linear Pattern – Active Pattern Scale

The **Active Pattern Scale** is used to change the size of the pattern cell. Scale value:

- 0 to 1 decreases the cell size.
- 1, use default cell size as drawn in the cell library.
- Greater than 1 increases the cell size.

Note, the active pattern scale can be automatically adjusted by the **Complete** and **Multiple** Cycle Options.

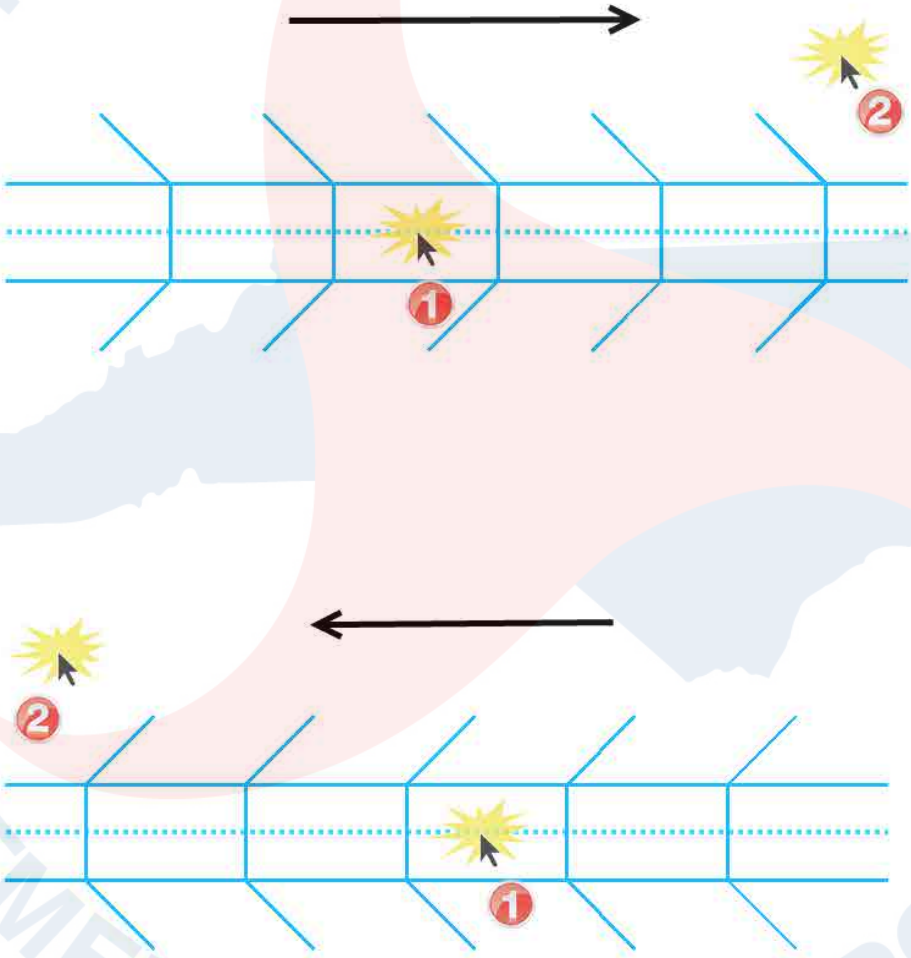
3. Turn off the ditch base line level. Choose the ditch centerline (blue) and then data point to lower part of the screen indicating the direction of the chevrons.



Note the ditch chevrons took on the level and symbology of the base line when using the **Linear Pattern** command.

Modified Ditch Chevron "Pointing" Direction Convention

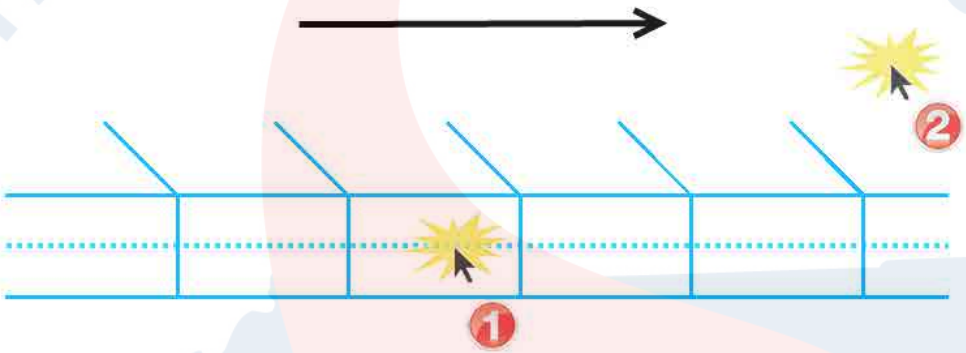
The Roadway ditch pattern cells were recently recreated to make it easier to draft the ditch contours into plan view. With the new convention, the ditch centerline is the only line required to be selected. The direction the chevrons point (opposite direction of the way the water is designed to flow) is determined with second data point.



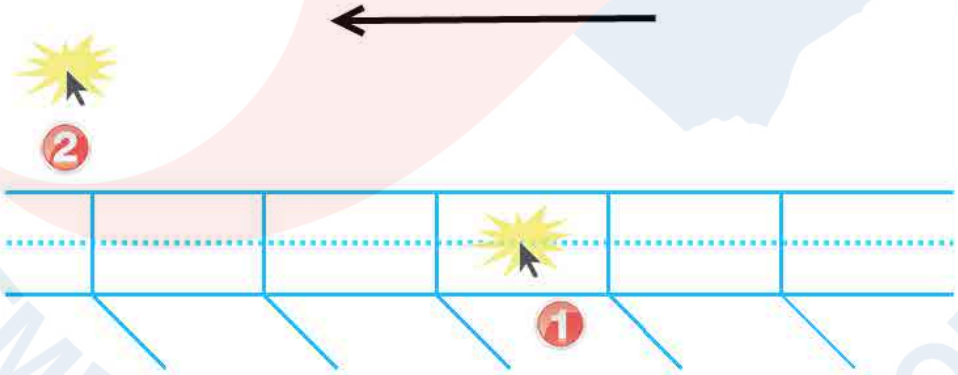
Outside and Outside Reflect Ditch Pattern Cells

Sometime only the ditch base and back slope contours are required to be shown. Mostly it is used in a Roadway cut section where the inside ditch boundary does not exist. Other time the ditch front slope is different from the back slope or it's not desirable to show the inner boundaries to avoid confusion all together. Ditch pattern cells labeled **Outside** and **Outside Reflect** were created for this purpose.

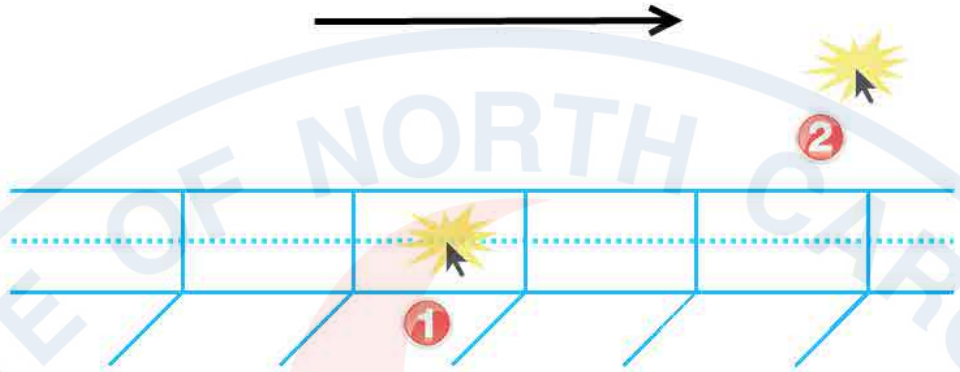
Outside



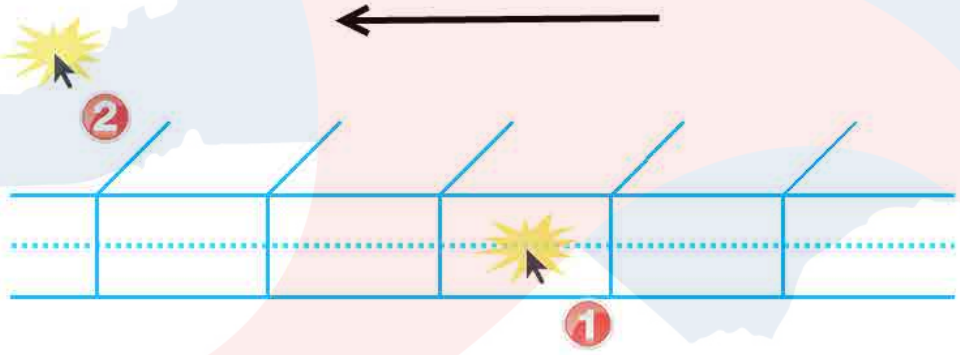
Outside



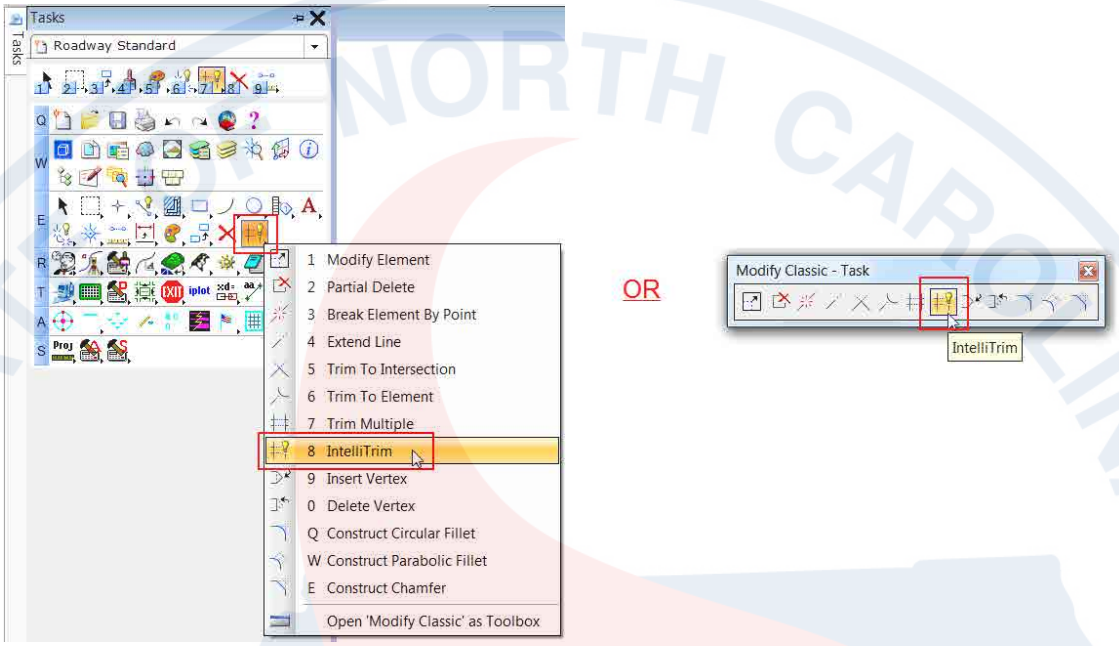
Outside Reflect



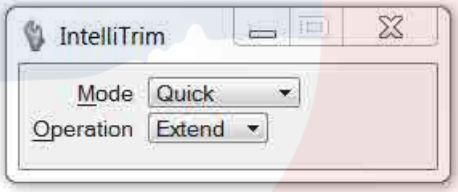
Outside Reflect



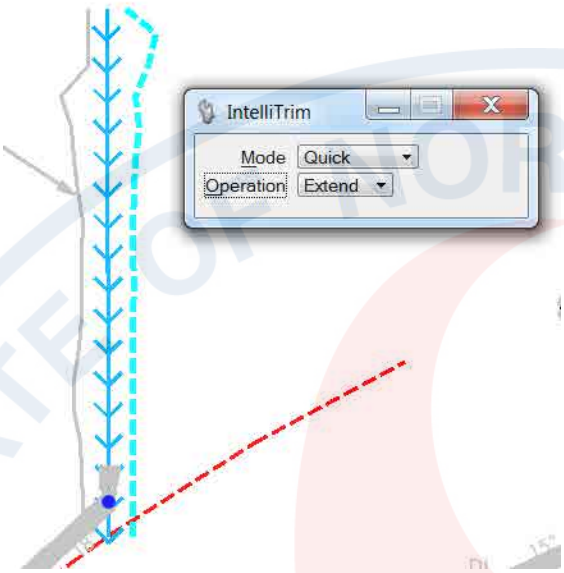
4. Open the Microstation **IntelliTrim** toolbox. Note **IntelliTrim** was manually added to the Modify 'Classic' tools (did not previously existed) as part of the **Roadway Standard Task** Tools Layout.



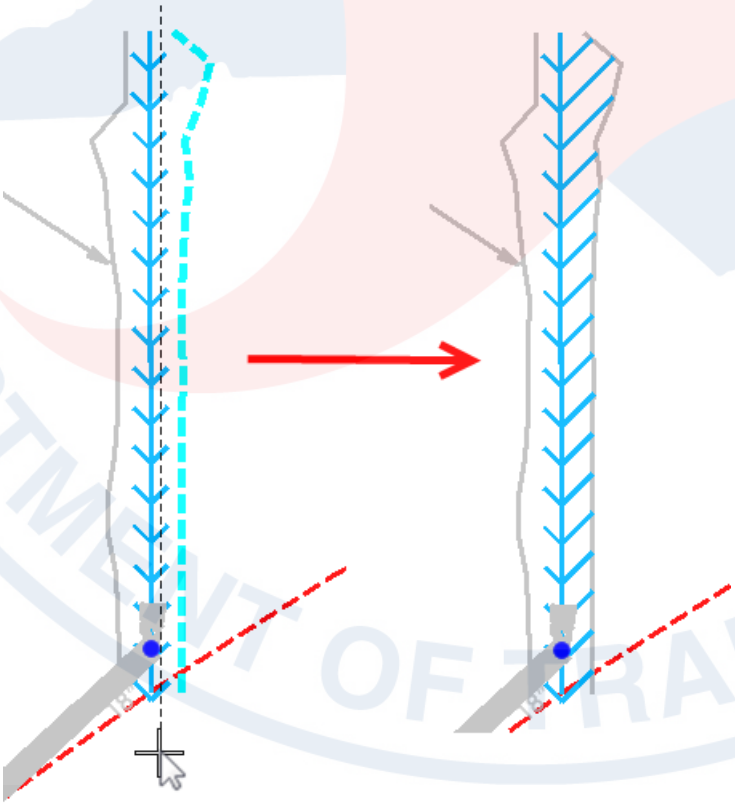
5. Set **IntelliTrim** to **Quick Extend** mode.



6. Identify the right ditch boundary to extend the right ditch chevrons to.

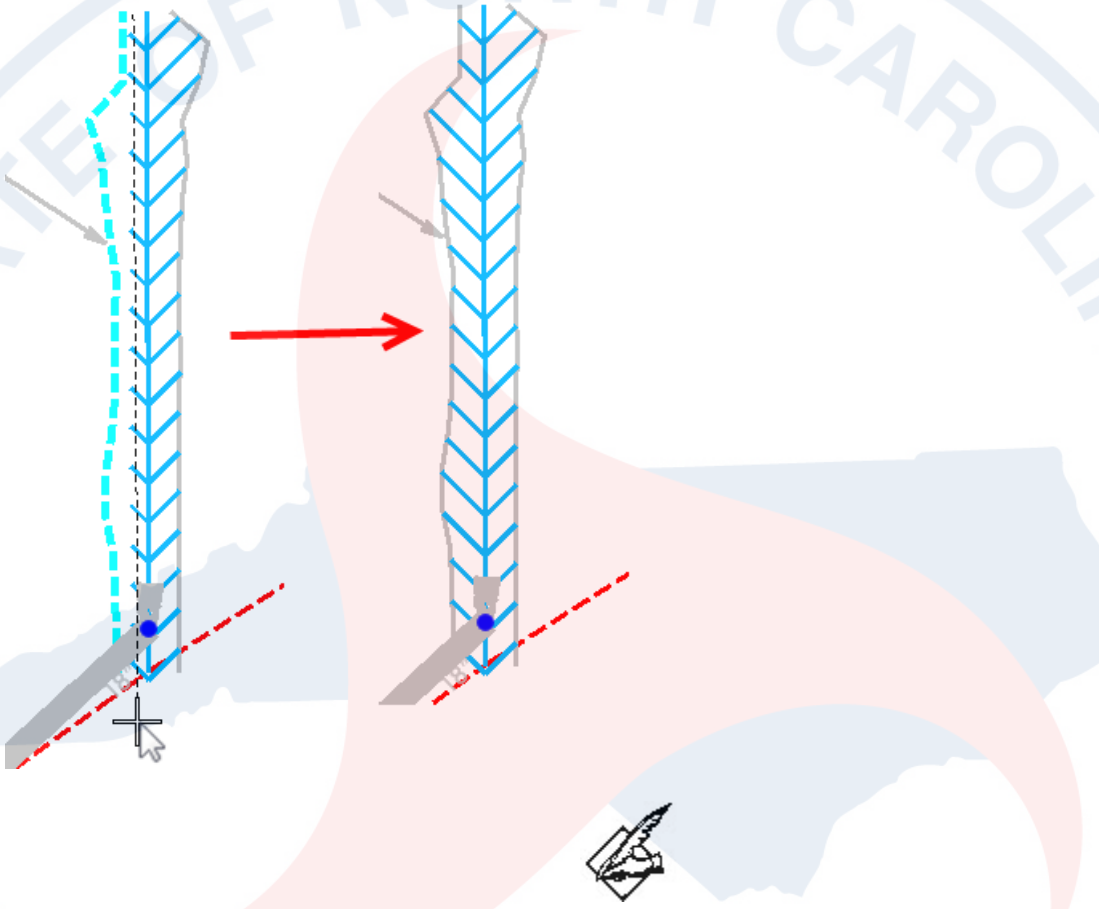


7. Create a line crossing the right ditch chevrons to extend them to the highlighted right boundary.



8. Reset the command with a right mouse click and identify the left ditch boundary to extend the left ditch chevrons to.

9. Create a line crossing the left ditch chevrons to extend them to the highlighted left boundary.

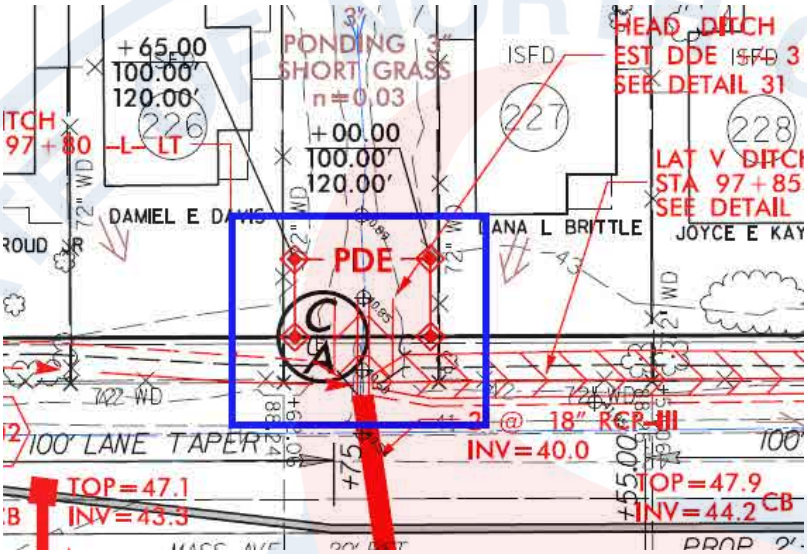


IntelliTrim vs. IntelliExtend

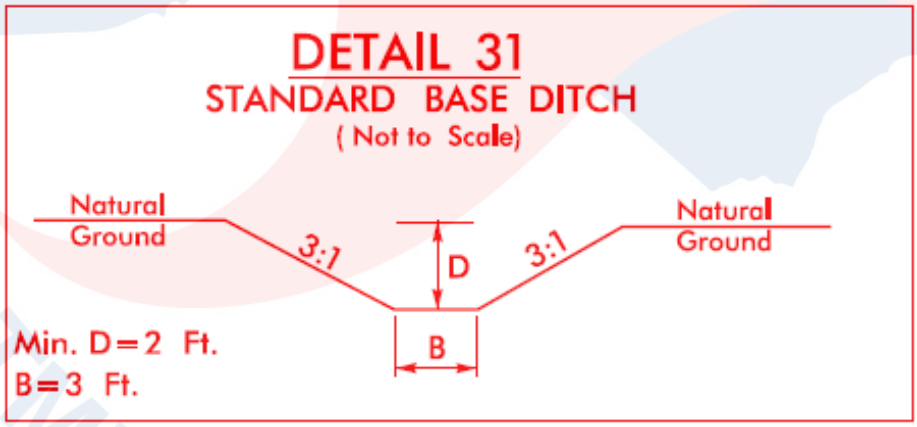
The ditch slope chevrons were created at an optimal length of 6’ for use with IntelliTrim **Quick Extend** (to the ditch outer boundaries) operation. For narrow ditches, when the ditch slope chevrons are longer than the ditch boundary limits, use the **Quick Trim** operation and create a line crossing the chevrons to the outside. Sometime it is necessary to use a combination of both or the basic (slow) **Trim to Element** Microstation command to do one chevron at a time.

Independent Class Exercise 01 - LT_L-HAT_097+83 (5 min)

There is a proposed head ditch by Hydro near the beginning of plan sheet 11 (**U4751_HYD_PSH_S11.PDF**) on the left side (blue box).



Use ditch **Detail 31** for the dimensions of the head ditch.



Use the previous instructor led exercise as an example. Create a model of the head ditch and draft it into the 2D file. Start at the Corridor Modeling **Plan Graphics** section. Remember to reload the GPK, RDP, and IRD.

- Guide

Corridor Modeling – Plan Graphics

Draw head ditch centerline from point #3 to #4.

New Chain Name: LT_L-HAT_097+83
Drafting Standard: DNC

Roadway Designer – Managed Corridors

Name: LT_L-HAT_097+83
Type: Alignment
Horizontal Alignment: LT_L-HAT_097+83
Vertical Alignment: None

Roadway Designer – Template Drops

Corridor: LT_L-HAT_097+83
Station: 0+00.00
Interval: 10
Template: LT Head and Tail Ditch – DDE

Roadway Designer – Parametric Constraints

Constraint Label: DD_Base Width LT
Start Value: -3
Stop Value: -3

Roadway Designer – Point Controls

Point: LT_DD_Base In_P-CTL-DDE
Mode: Vertical
Control Type: Elevation and Grade
Elevation: 40.00 (outlet pipe invert elevation)
Grade: 7.13% (measured)

Create Surfaces – Draw 2D Features into DGN File

New Surface for Each Corridor (on)
Empty Design Surface (on)
Features (on)

Ditch Drafting - Linear Pattern*

Cycle: Truncated
Pattern: Lateral 3ft Base Ditch Pattern
Scale: 1

Ditch Drafting - Linear Pattern (Alternative)**

Cycle: Truncated
Pattern: Lateral 6ft Base Ditch Pattern
Scale: 0.5

* The basic Microstation command **Trim to Element** can be used instead of IntelliTrim.

** The default linear pattern settings will produce one chevron because the length of the ditch is only 15' (10' pattern cells). The alternative linear pattern settings can be used to produce three chevrons.

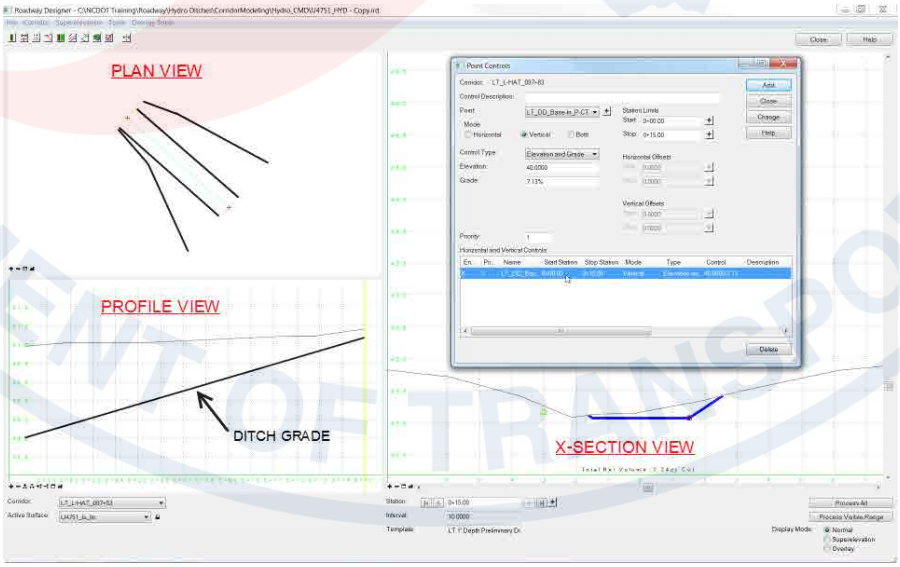
- Bonus

Determine a quick DDE quantity for this head ditch. Compare this number to the "estimated" DDE quantity by Hydro.

Models are not always pretty:
The Desired Ugliness of Engineering Accuracy and Precision

Sometime it is not aesthetically pleasing when head and tail ditches are modeled accurately using the terrain of the existing ground TIN. Compared to the traditional uniformity of straight line HAT ditches, they can be undesirable. However, engineering wise it is preferable that we analyze objectively what the models give us in order to make sound judgment and realize the impact our design have on the surrounding.

For instance in the previous head ditch exercise, to avoid an abrupt steep grade by tying the pipe invert elevation to natural ground, consider extending the length of the ditch. Determine a more precise drainage easement and impact to sensitive areas, based on the wider ditch width in the beginning and narrower near the end. The models can identify potential problems, which can then help us in re-evaluating our design. A more accurate DDE quantity can be obtain, rather than an estimated value base on nominal dimensions. This is the type of information not available to us previously with traditional straight line HAT ditches.



Lateral Ditch (LAD)

Lateral diches (LAD) reference the Roadway chain. LAD's are located on either side (lateral) of the Roadway corridor and usually water is designed to flow alongside the Roadway slope stakes. LAD's are drawn in the cross sections and incorporated into the Roadway plans. DDE and sometime Unclassified Common Excavation (UCE) quantities are computed and modeled as part of the grading surface.

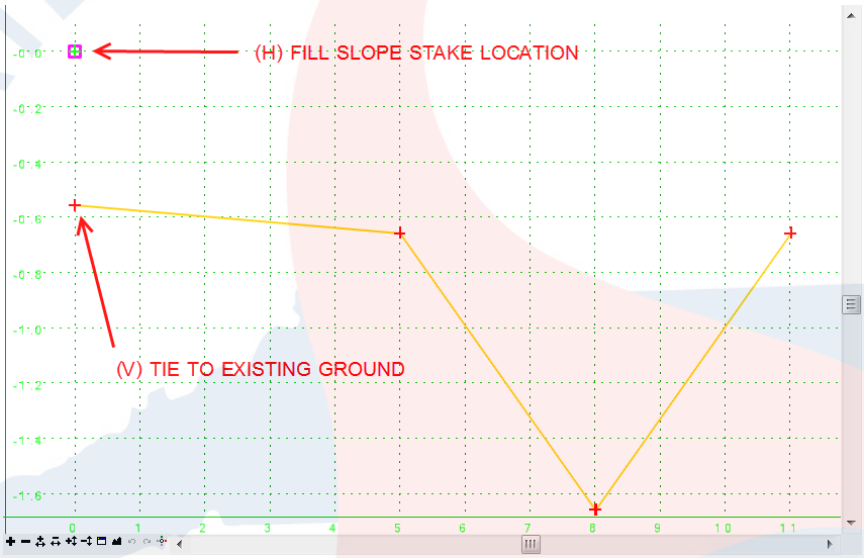
UCE vs. DDE

If the lateral ditch is part of the Roadway grading operation then it is usually computed and paid for as regular Unclassified Common Excavation (UCE - Green). If the lateral ditch is NOT part of the Roadway grading operations, then it is usually computed and paid for as Drainage Ditch Excavation (DDE – Yellow).

Basic Lateral Ditch Templates

Most lateral ditch templates use a pair of points to locate the ditch origin. A null point with a style constraint is used to locate **horizontally** a 2D plan graphic, such as the slope stake limits. Another point with a "Project to Surface" (tie to the existing ground) is used to control the **vertical** aspect of the ditch origin.

Lateral Ditch with Berm - DDE

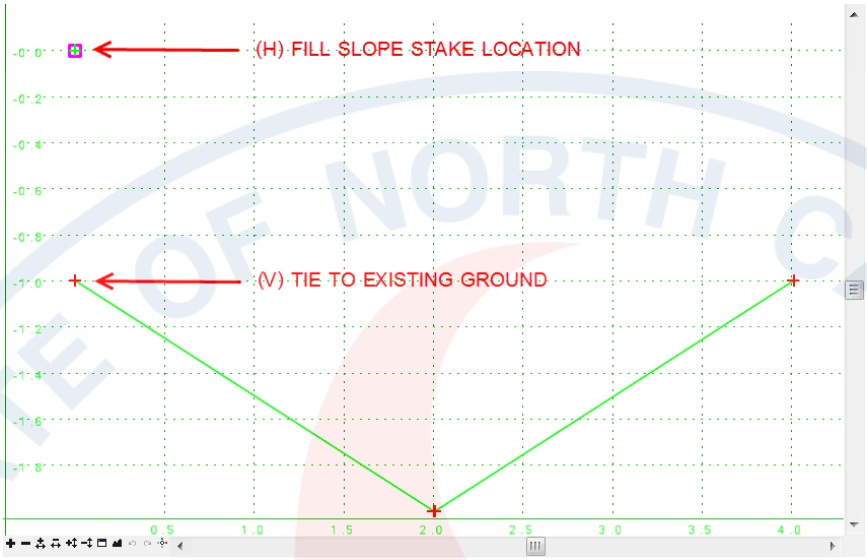


Used mainly for lateral ditches with a berm width (DDE).

Lateral Ditch Components Not End Conditions

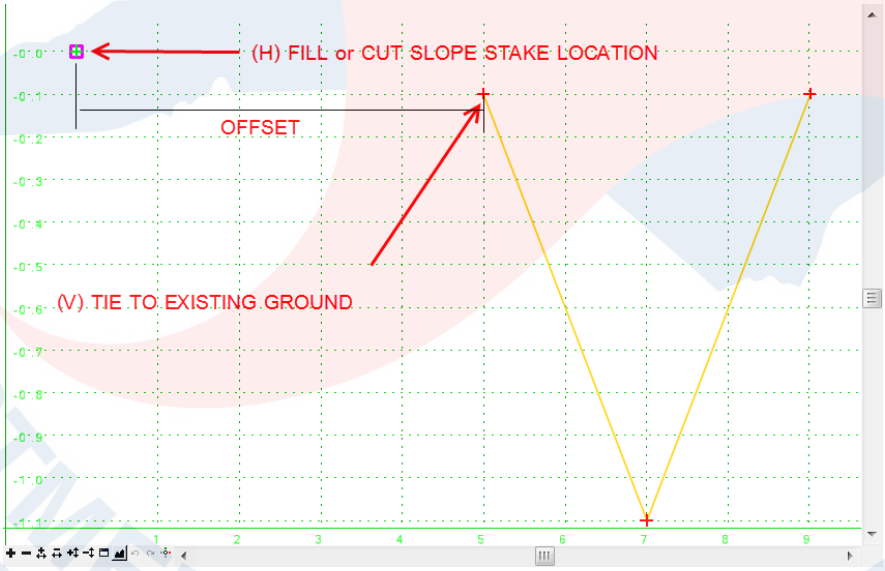
Most lateral ditch templates were created using regular components instead of end condition components. This is primarily due to a problem (bug?) end condition components have when used in conjunction with the "Project to Surface" constraint. The end condition components "disappear" as a result.

Lateral Ditch - UCE



Used mainly for extending Roadway fill slopes into a cut section (UCE).

Lateral Ditch with Offset - DDE



Used mainly for special berm ditch standard 240.01 (offset from cut slope stakes) or extending a ditch system beyond the bridge pier protection (no slope stakes). It is usually computed as DDE.

Working Folder and Files

Folder:
C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Hydro_CMD

Active File:
U4751_HYD_CMD_2D.DGN

RDP:
U4751_HYD.RDP

ITL:
U4751_HYD.ITL

GPK:
HYD

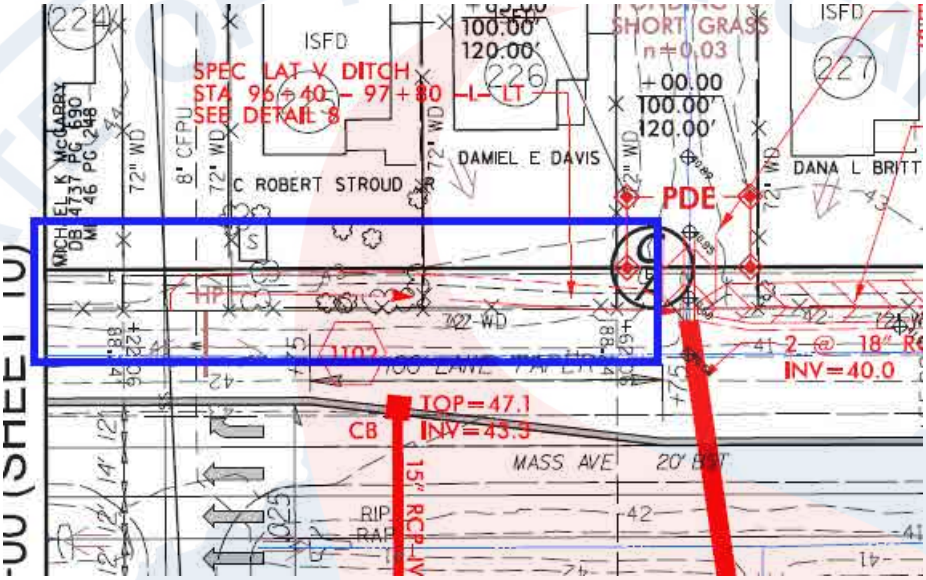
IRD:
U4751_HYD.ITL

Plan Sheet:
U4751_HYD_PSH_S11.PDF

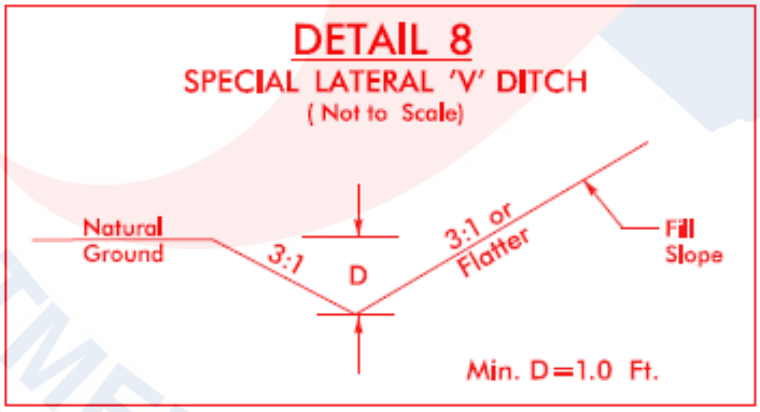
Profile Sheet:
U4751_HYD_PSH_S38-PFL.PDF

Cross Section File:
CorridorModeling\U4751_RDY_XSC_L.DGN

In the beginning of plan sheet 11 (**U4751_HYD_PSH_S11.PDF**), there is a proposed lateral V ditch on the left side of the road. The roadway fill slope is extended to a cut section (UCE). The flow arrows indicate the desired direction of water flow.



Use ditch **Detail 8** with this ditch model.

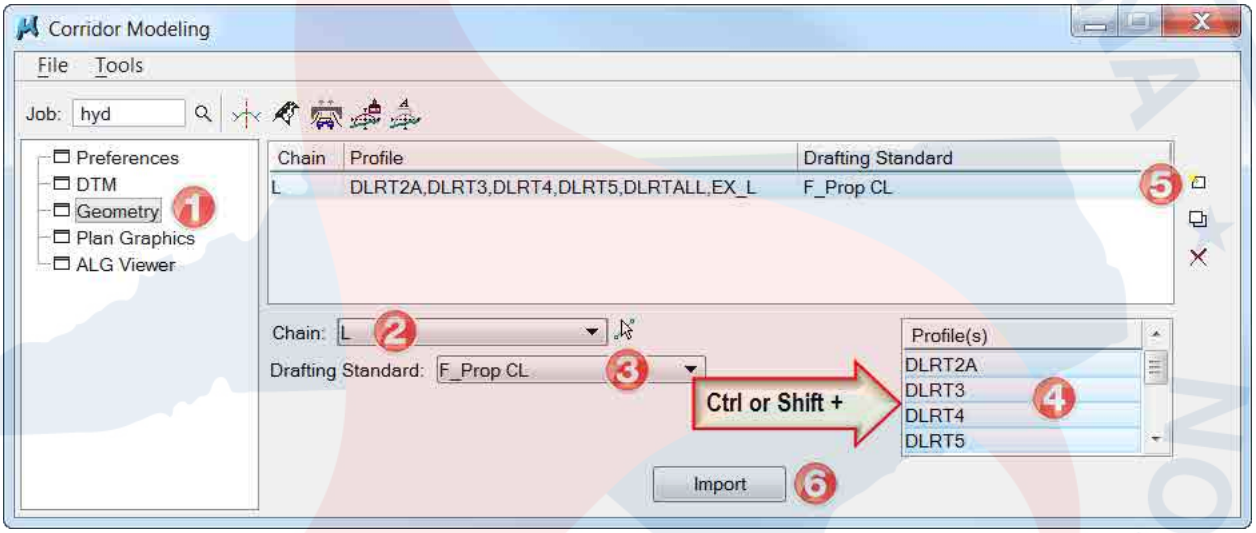


Corridor Modeling – LT_L-LAD_096+40-97+80

Geometry

1. After loading the HYD GPK and U4751_HYD.rdp in the Corridor Modeling dialog box, in the **Geometry** tab, **Import** the L GPK information with the following settings. Remember to hold down the **shift** (range) or **Ctrl** (individual) key to add multiple profiles associated with one chain to the list.

Chain: L
Drafting Standard: F_Prop CL
Profile(s): DLRT2A, DLRT3, DLRT4, DLRT5, DLRTALL, EX_L



2. **Save** the RDP file.

None vs. Dummy Profile

Technically no corridor profiles are needed to be associated chain L since the ditch will have its own grade. However it is highly recommended selecting the existing or proposed corridor profile(s) when available. The effect will place the null point(s) near the ditch components instead of at elevation 0'.

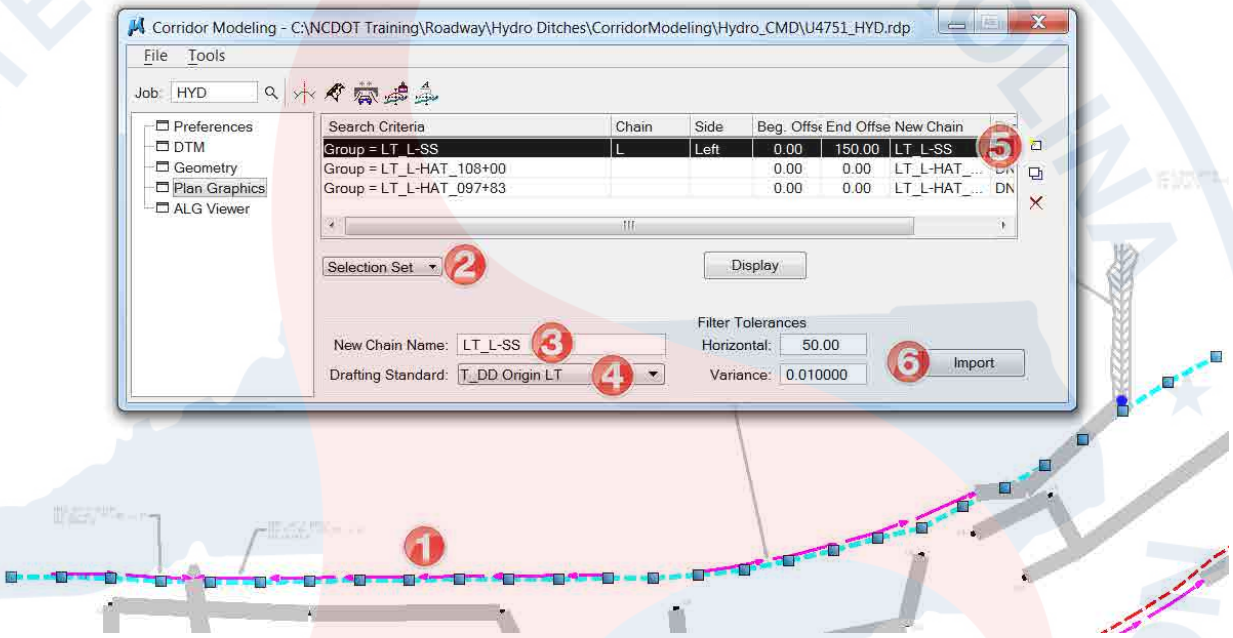
Update Geometry Reset Bug Warning

Although ditch profiles can be added later and the corridor geometry updated, the associated chain in Roadway Designer **Managed Corridors** would have to be reselected ("new" updated chain) and also the associated profile (defaults back to "None"). The corridor station range is then reset back to the entire chain or profile length. The saved corridors would have to be reconfigured and resaved. **When possible** (sometime understandably unavoidable), import known ditch profiles before creating a new corridor to avoid the update geometry reset bug.

Plan graphics

3. In the **Plan Graphics** tab, store the left side slope stakes using **Selection Set** or **Symbology** with the following settings:

New Chain Name: LT_L-SS
Drafting Standard: T_DD Origin LT

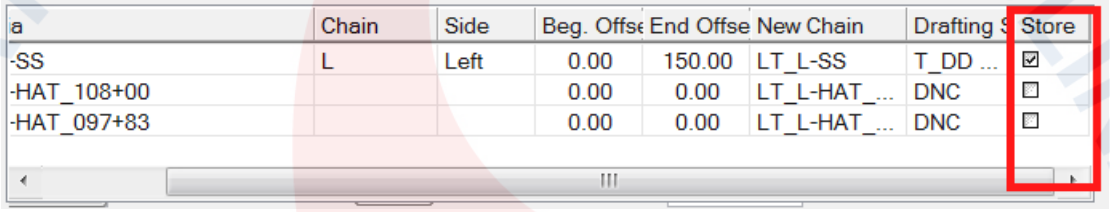


4. Uncheck box under the **Store** column.

5. **Save** the RDP file.

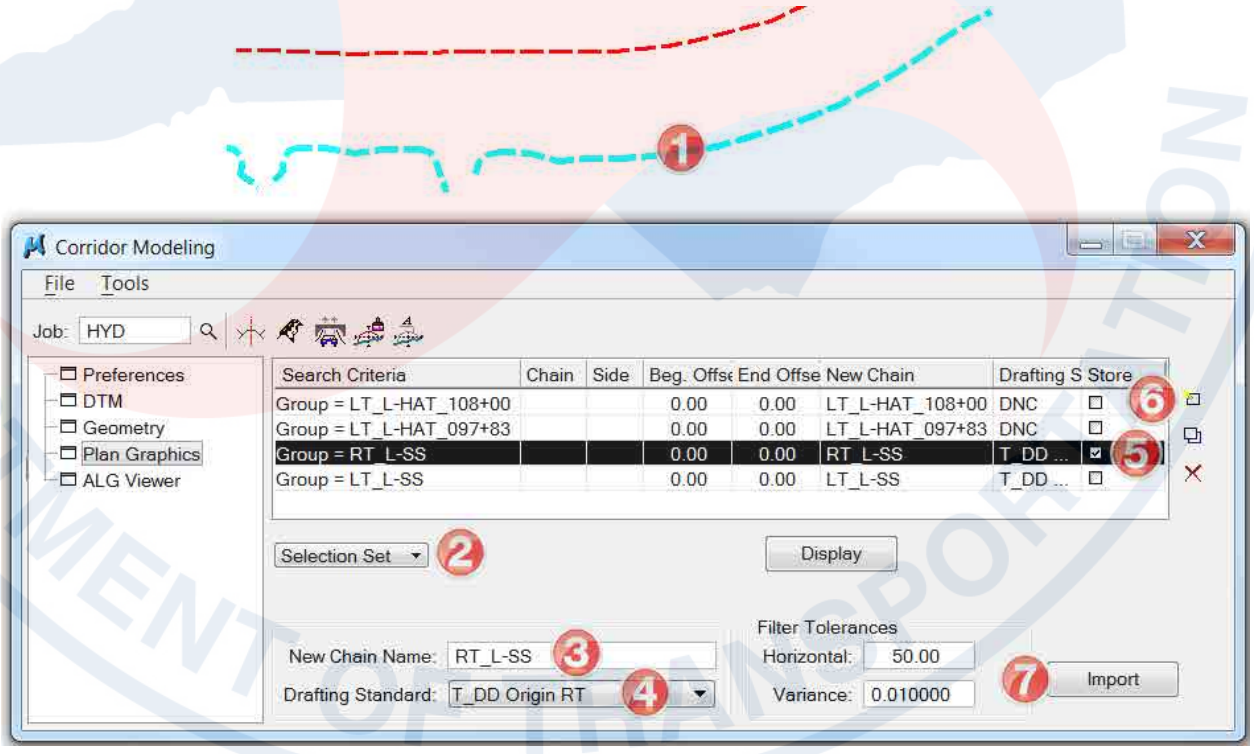
Store Only New Graphics

For graphics previously imported successfully, uncheck the “Store” column (far right) so they will not be re-imported. If the store column is checked and one of the line item has a problem with the import process, then you must start over re-storing and re-importing all the plan graphics.



a	Chain	Side	Beg. Offse	End Offse	New Chain	Drafting S	Store
-SS	L	Left	0.00	150.00	LT_L-SS	T_DD ...	☑
-HAT_108+00			0.00	0.00	LT_L-HAT_...	DNC	☐
-HAT_097+83			0.00	0.00	LT_L-HAT_...	DNC	☐

6. **Store** the right side slope stake limits as plan graphics.



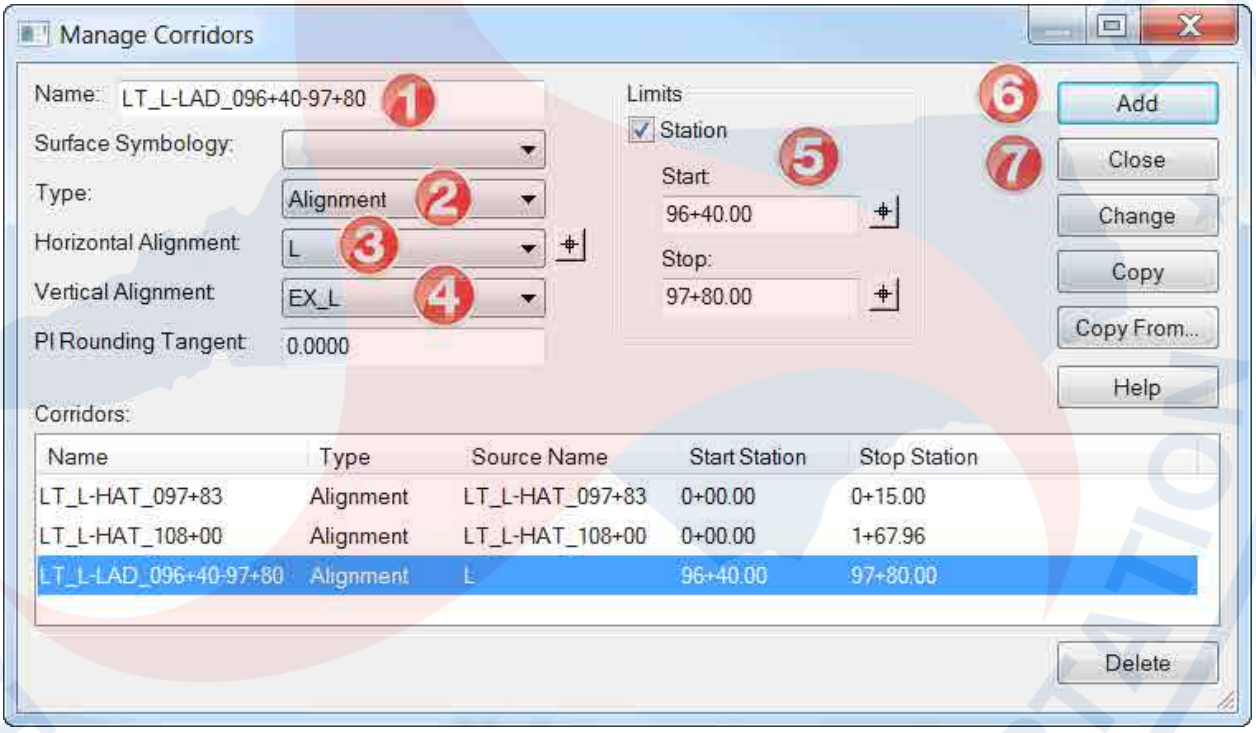
7. Uncheck box under the **Store** column and **Save** the RPD file.

Roadway Designer – LT_L-LAD_096+40-97+80

Managed Corridors – Create New Ditch Corridor

1. After loading the U4751_HYD.ird in **Roadway Designer**, create a new corridor in the **Managed Corridors** dialog box with the following settings:

Name: LT_L-LAD_096+40-97+80
Type: Alignment
Horizontal Alignment: L
Vertical Alignment: EX_L
Start Station: 96+40.00
Stop Station: 97+80.00



2. **Save** the IRD file.

Standard Ditch Naming Convention

Standard ditch naming convention should be *LOC_CHA-LAD_BEG STA -ENDSTA.*

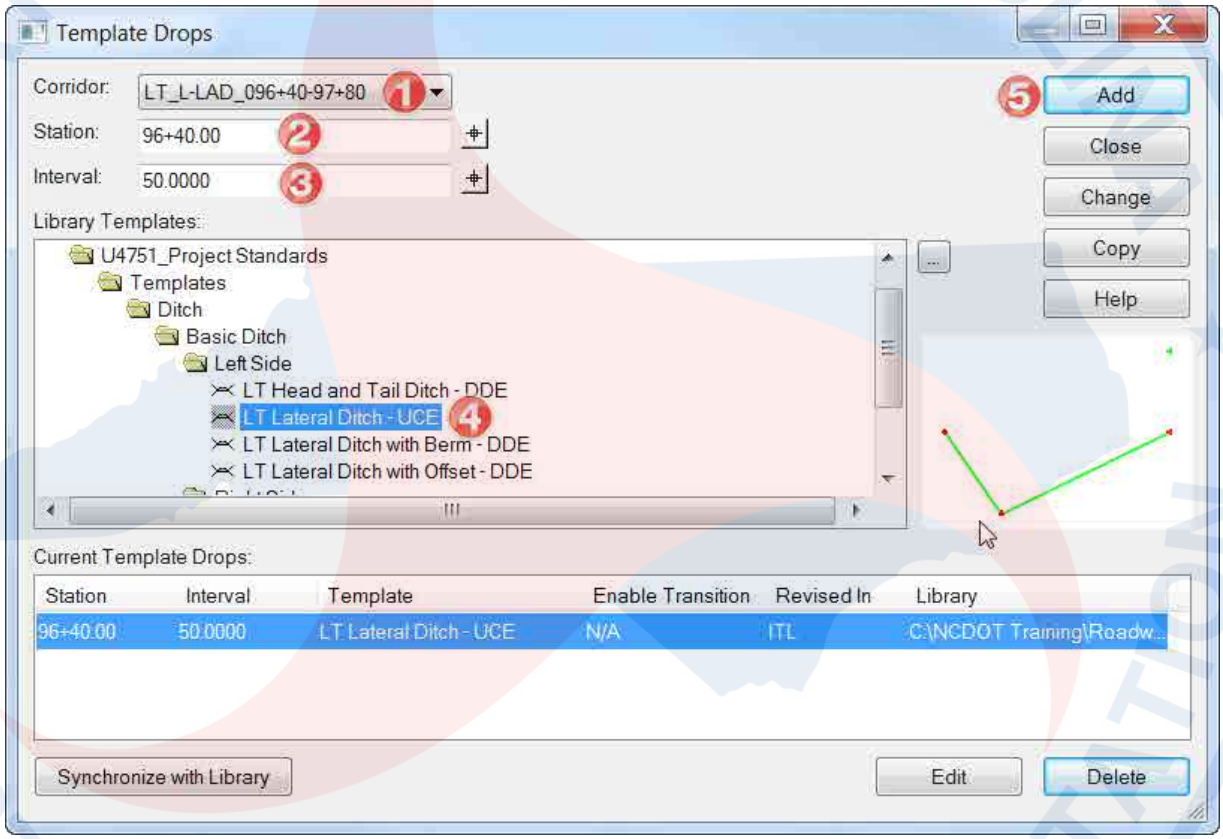
RT_L-LAD_097+83-104+20
LT_Y8-LAD_12+86-24+50
LT_RPA-LAD_18+65-22+60

Note a zero was added to the beginning station for the first example (012+34). This was done to insure proper sorting order when for ditches further down the road (123+45).

Template Drops – Corridor Template Selection

3. In the **Roadway Designer Template Drops** dialog box, **add** the following template drop and settings:

Corridor: LT_L-LAD_096+40-97+80
Station: 96+40
Interval: 50
Library Templates: LT Lateral Ditch - UCE



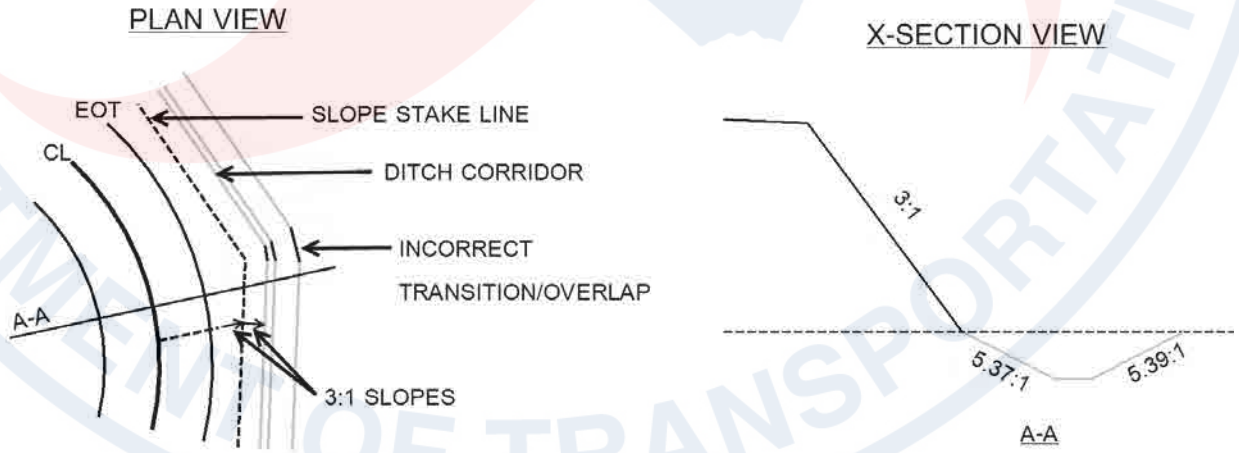
4. **Save** the IRD file.

Resetting Template Drops Interval

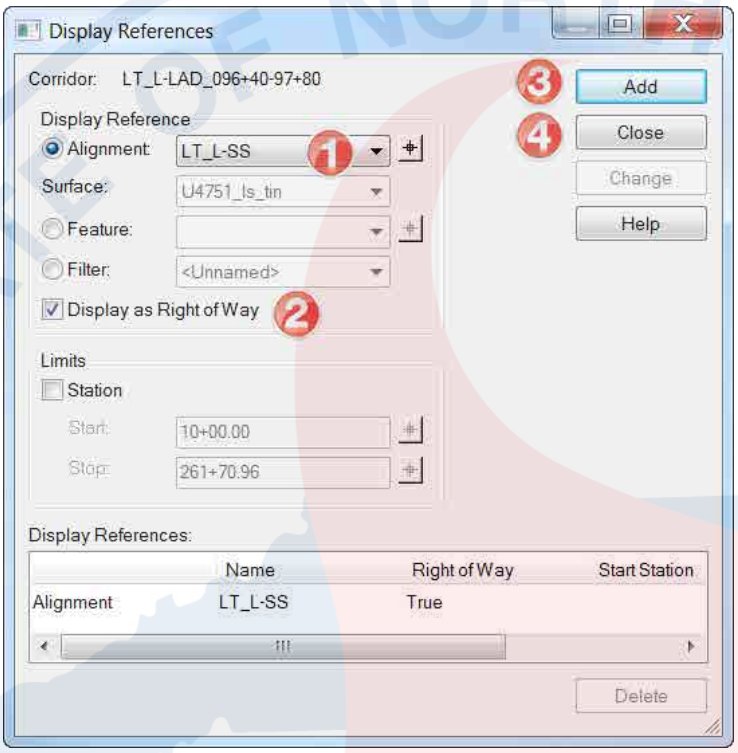
When necessary it is important to reset the template drops interval so they are aligned with Roadway's cross sections (25' or 50' even increments). Having inconsistent intervals will have a negative impact on lateral ditches not aligned with the slope stakes in the XSC and in the 2D plan graphics file. Since Station Lock was set to Even in the Corridor Modeling Preferences tab, there is no need to add another template drop to aligned with cross section 50' even stationing.

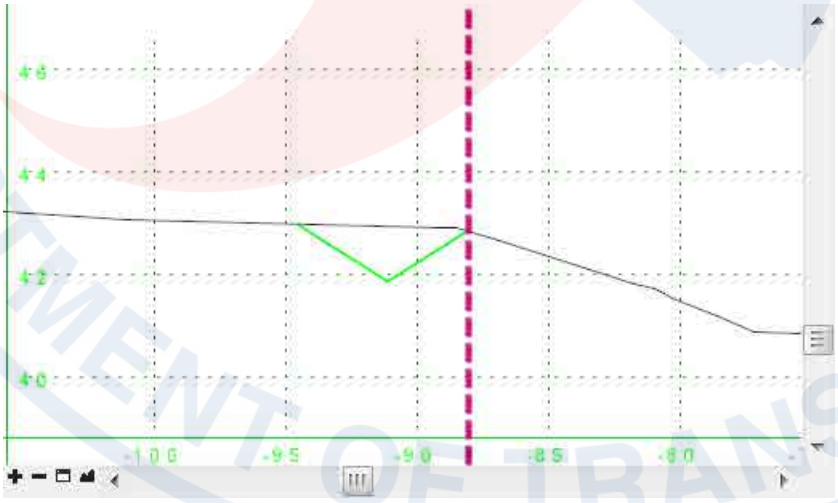
Linear Templates and the Skew Effect Error

Along with resetting the template drop intervals, it is highly recommended lateral ditches use the road corridor horizontal alignment as the referenced chain. If the slope stakes are used as the corridor horizontal alignment, then the ditch slopes will have a skew effect error when cross sections are cut from the roadway corridor. Inaccurate component transition or overlaps of the ditch corridor can also occur.



5. To verify the horizontal location of the slope stakes (stored as 2D plan graphics), turn on **Display References**. A purple dashed line is display in the cross section view indication the horizontal offset location from the centerline.

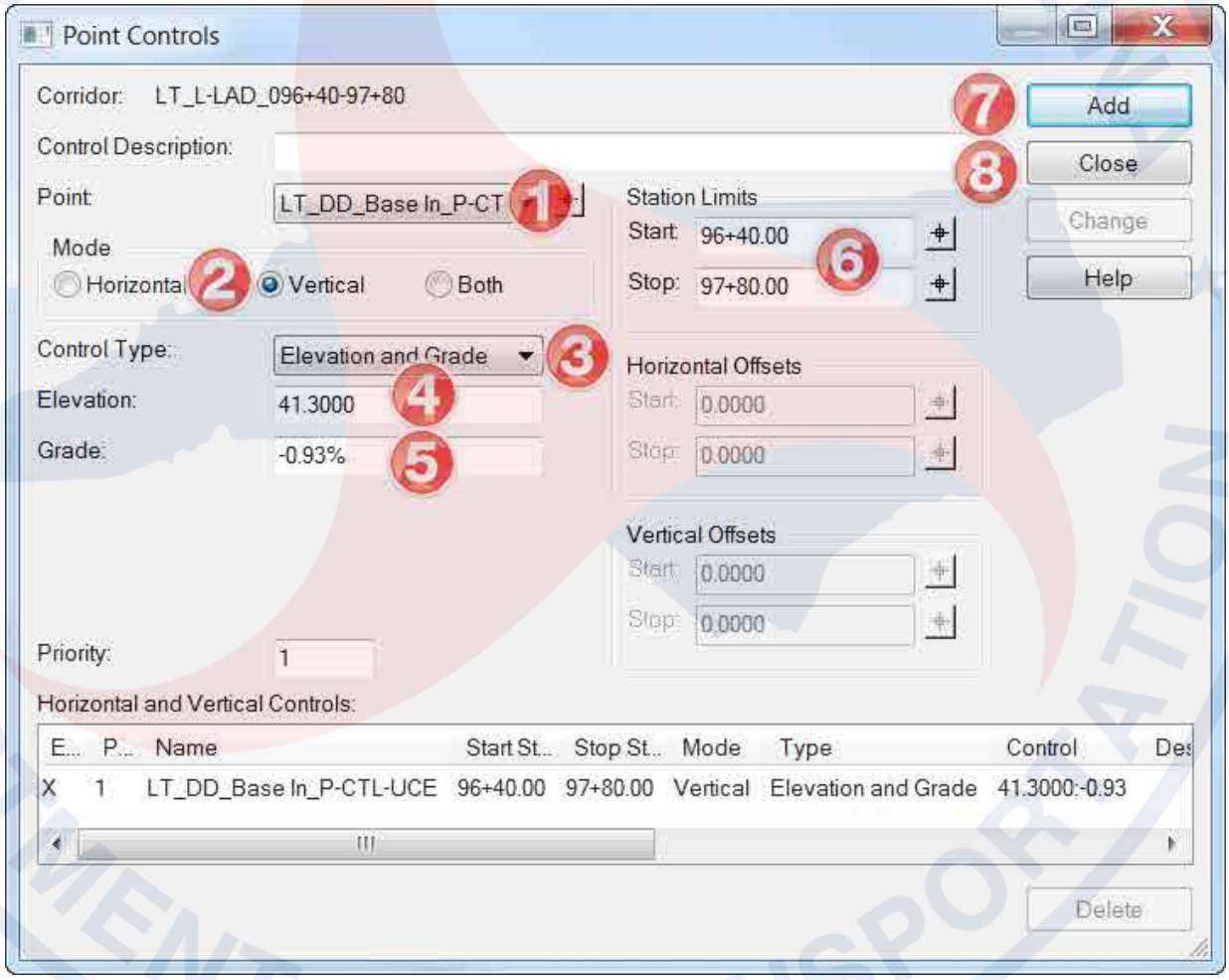




Point Controls – for Ditch Grade

6. In the **Roadway Designer Point Controls** dialog box, add the following point control settings for the ditch grade **(point control is for the entire length of the corridor – start/stop station)**:

Point: LT_DD_Base In_P-CTL-UCE
Mode: Vertical
Control Type: Elevation and Grade
Elevation: 41.30 (U4751_HYD_PSH_S38-PFL.PDF)
Grade: -0.93% (U4751_HYD_PSH_S38-PFL.PDF)



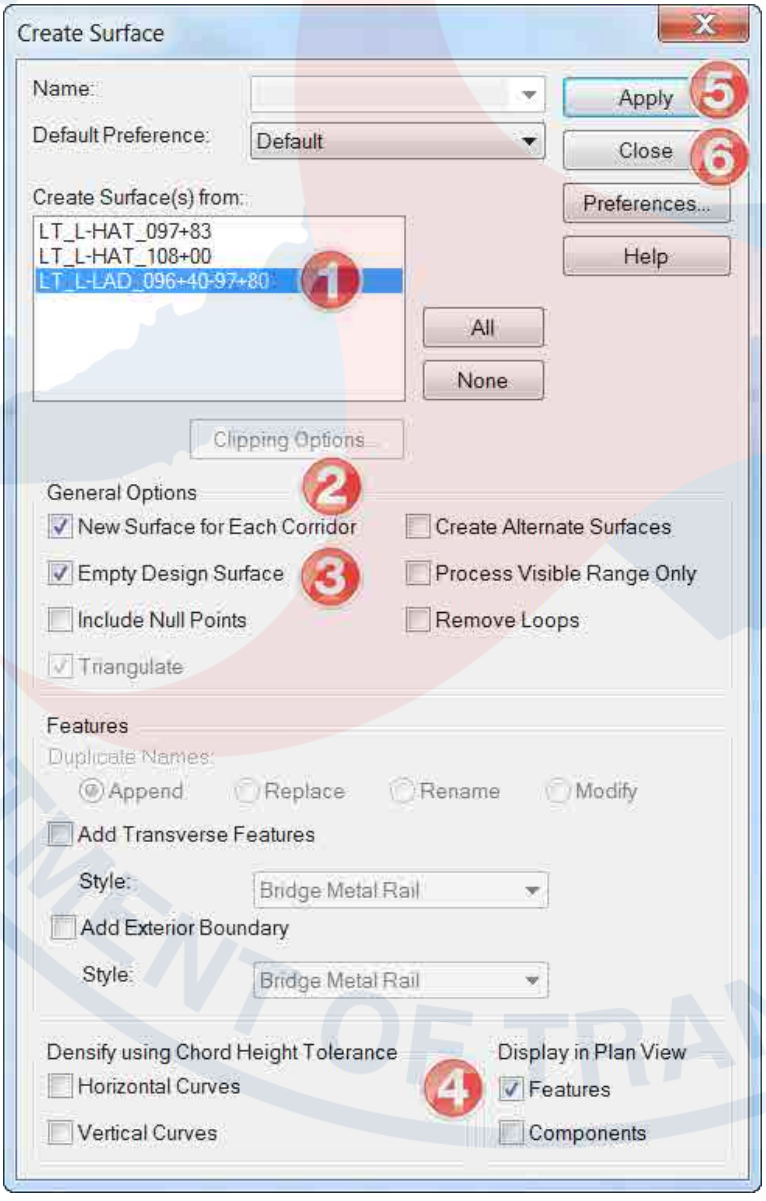
Create Surfaces – Ditch Layout in 2D Plan View DGN File

7. **Process All**.

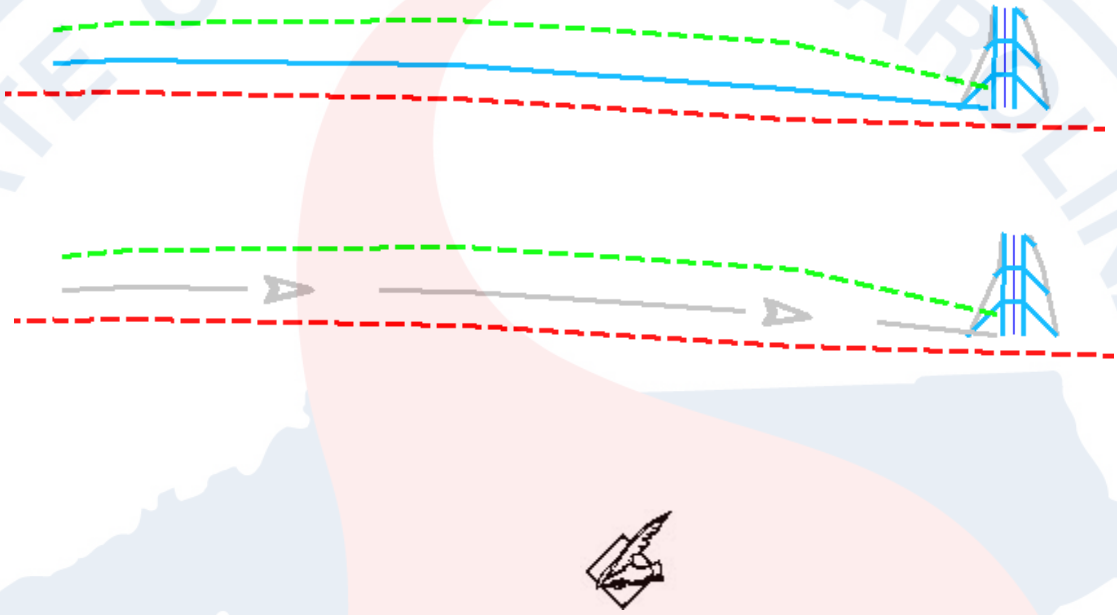
8. **Save** the IRD file.

9. In the **Roadway Designer Create Surface** dialog box, create the proposed ditch DTM/TIN with the following settings:

New Surface for Each Corridor (on)
Empty Design Surface (on)
Features (on)

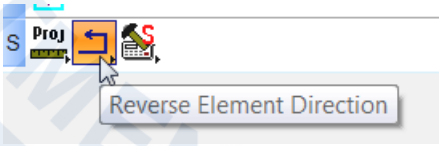


Once a roadway fills section, indicated by the red dashed line, the side slope has been extended to a ditch grade making it a cut section. The ditch outside boundary is automatically plotted out on the slope stake cut level (green dash). Change the ditch centerline to level **Prop Drainage Ditch Flow Line**.

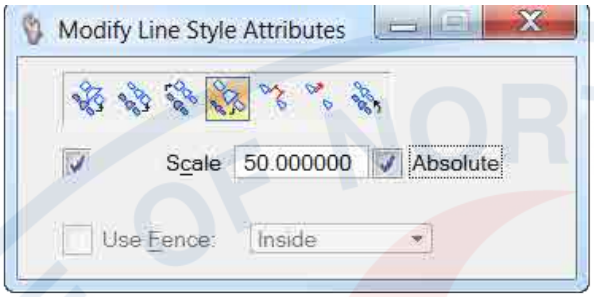


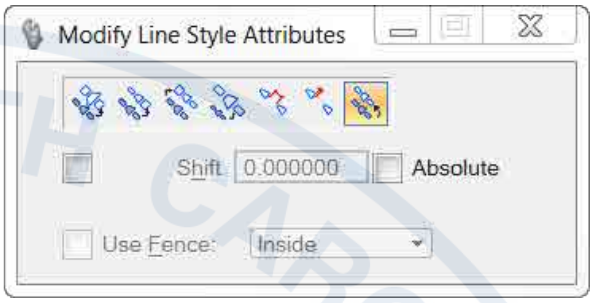
Line Style Reverse Direction and Scale/Cycle Options

To change the direction of the flow arrows (as part of a custom line style element type), use the NCDOT **Reverse Element Direction** tool.

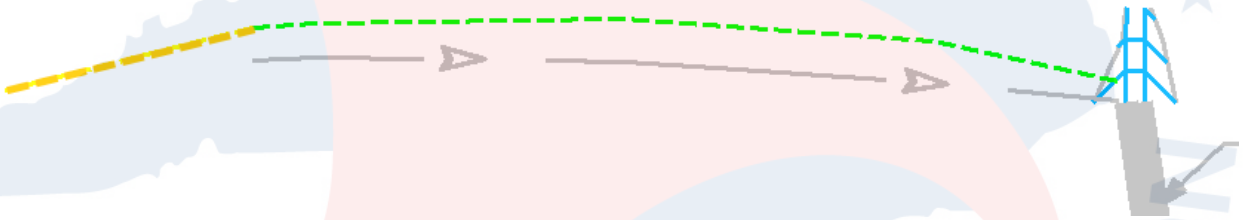


The size and cycle options of the flow arrows are affected by the line style **Scale** and **Shift** setting.





Bear in mind, the slope stake limits are referenced in from another file. Ultimately the flow arrows can be copied into the DRN and slope stakes modified in the SS DGN file. The inside boundary can deleted.



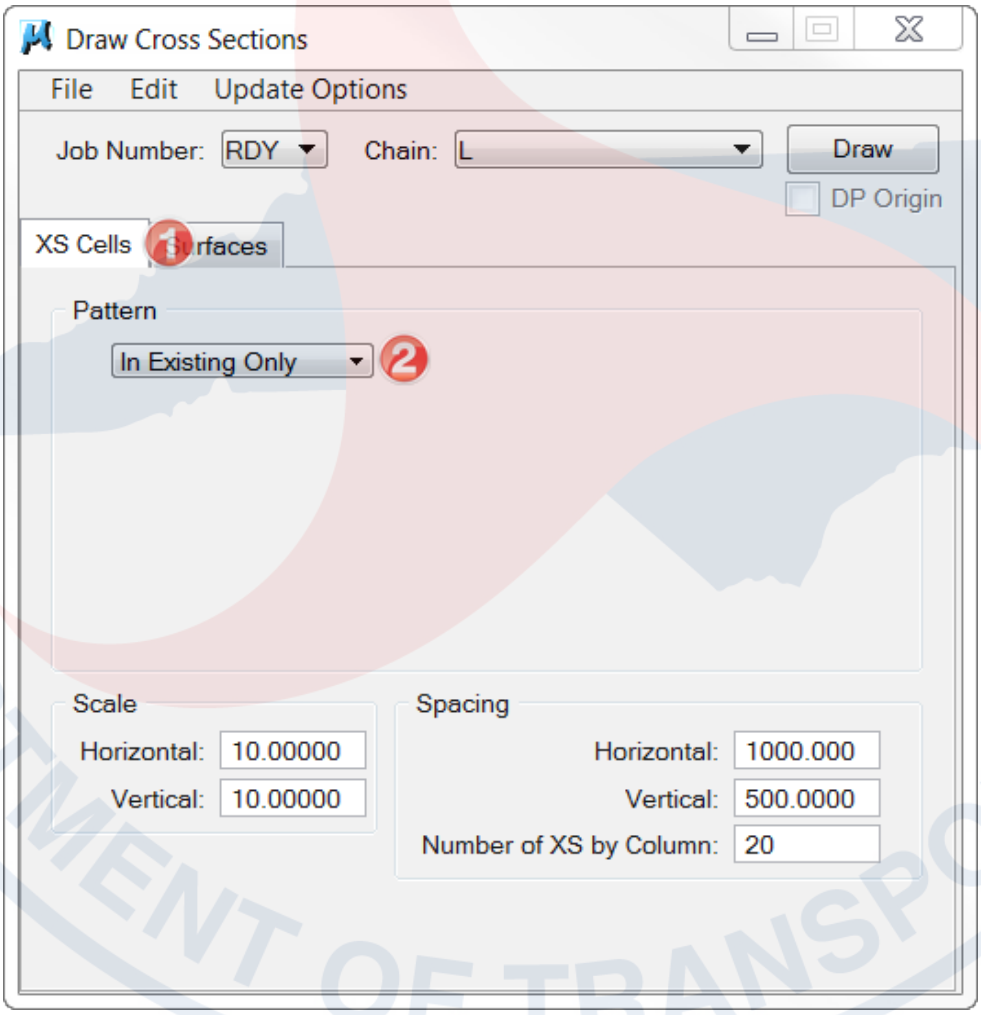
Alternate Drafting Practice: since the original fill slopes can no longer be used to define the ditch front slope and inner boundary, this lateral ditch can also be drafted using the **Outside** and **Outside Reflect** pattern cells only showing the ditch base line and back slope.

Incorporate Ditch Model into the XSC - LT_L-LAD_096+40-97+80

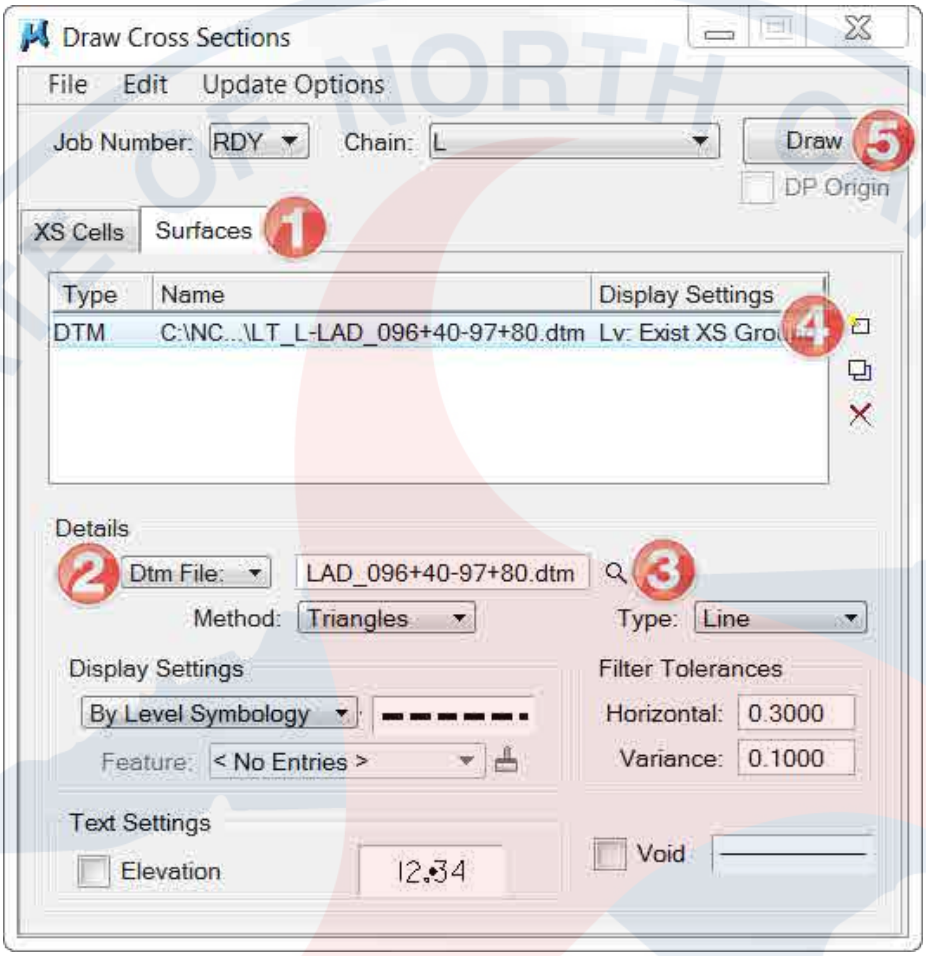
Even though a new cross section (XSC) file can be created and both the proposed road and new ditch DTMs can be cut at the same time or the ditch can be cut by itself in a file, the following procedure shows a quick way to incorporate the newly created ditch model into an existing set of Roadway cross sections.

1. Go to the Roadway's **CorridorModeling** folder (back one), and open the **U4751_Rdy_XSC_L.dgn** file.

2. In the Geopak **Draw Cross Sections from Surfaces** tool, select the **RDY GPK** and **L Chain**. Configure the **XS Cells** tab to **Pattern In Existing Only**.



3. In the **Surfaces** tab, add the **LAD_096+40-97+80.dtm** file to list of surfaces. Remember the ditch DTM is located in the **Hydro_CMD** folder. Click on the **Draw** button to draw the ditch in the XSC.



Cross Section Update Options

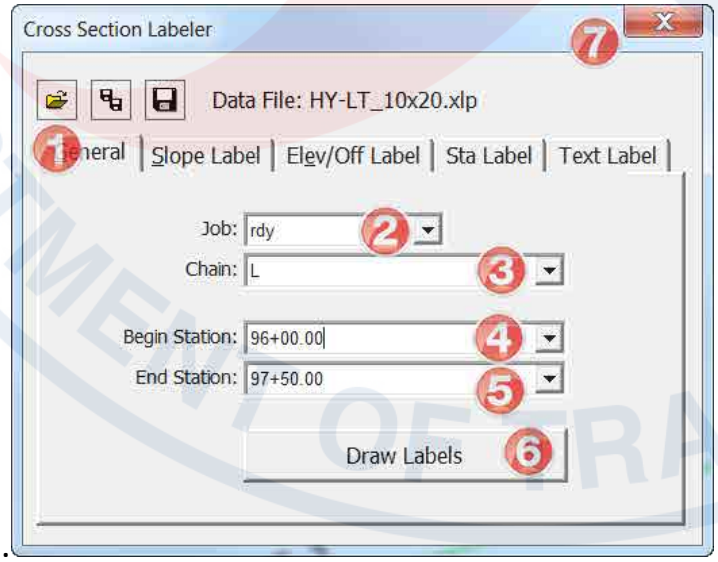
Sometime when drawing an existing ground TIN/DTM on top of existing ground that is already in the XSC, a prompt for how to update the cross sections appears. The choices are:

- Delete Existing Elements and Redraw
- Delete Non-Modified Elements and Redraw
- Draw on Top of Existing
- Query

In this case, **Draw on Top of Existing** is applicable. Sometime it is necessary to **Delete Existing Elements and Redraw** if the existing ground needs to be "refreshed". This option does not delete the proposed DTM elements.

---

4. To label the ditch, load the **HY-LT_10X20.xlp** preference file into the XSLabeler. Currently the XLP preference files can be found in the Roadway workspace (C:\NCDOT_V8_WORKSPACE\ROADWAY_STDS\English\geopak\Corridor_Modeling\XS_Labeler).



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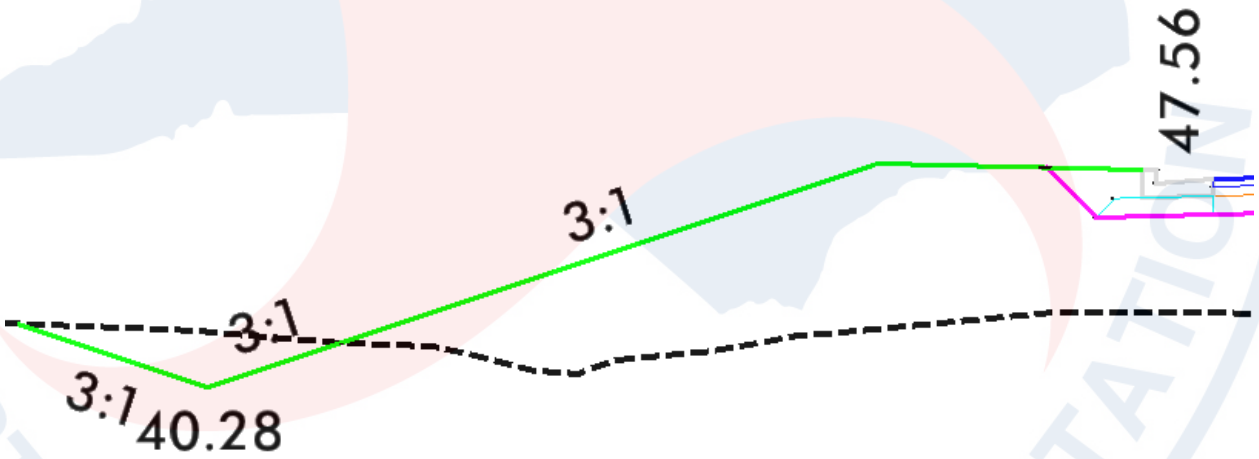
Hydro's Cross Section Labeler Preferences (XLP)

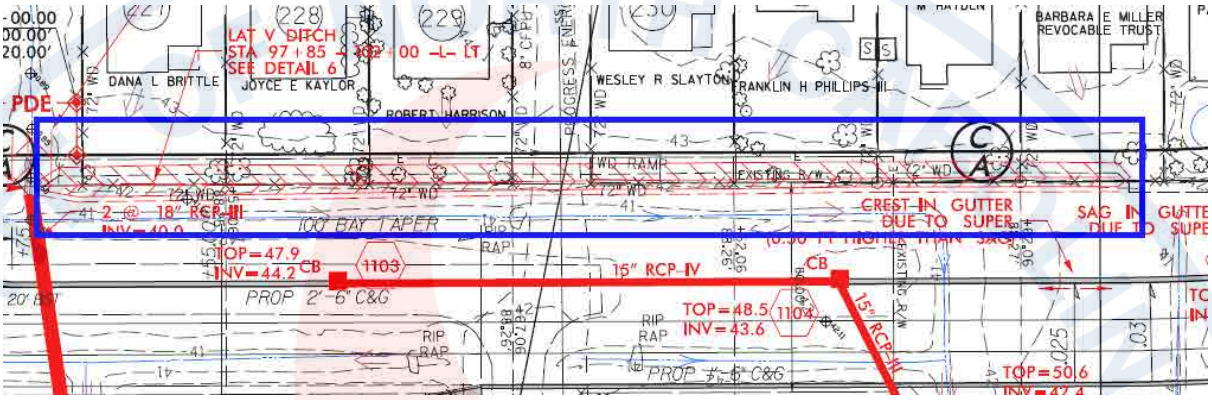
Hydro's XLPs are similar to Roadway's. They only label ditch slopes and elevation. They are separated into left and right side for more control of labeling ditches with overlapping station ranges. The various preference files indicate the text size for the different cross section sheet scale (matching Roadway's).

- 5x10 for cross section sheets 75' left and right of centerline.
- 10x20 for cross section sheets 150' left and right of centerline.
- 20x40 for cross section sheets 300' left and right of centerline.

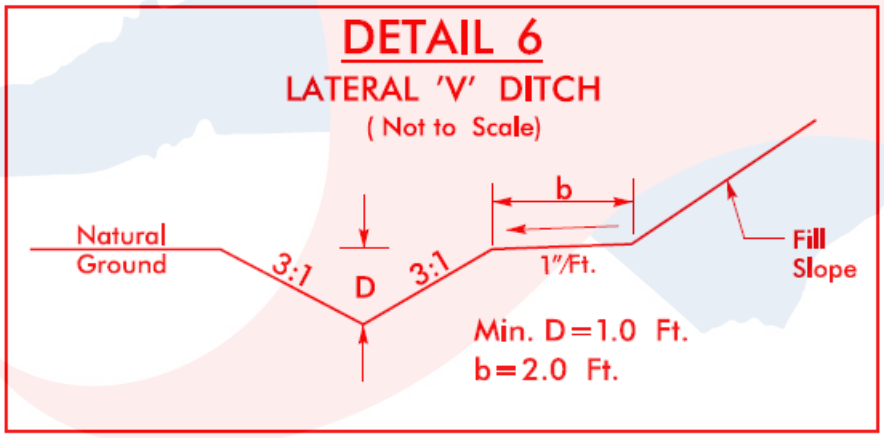


Independent Class Exercise 02 - LT_L-LAD_097+85-102+00 (5 min)

There is a proposed lateral V ditch with a 2’ berm by Hydro near the middle of plan sheet 11 (**U4751_HYD_PSH_S11.PDF**) on the left side (blue box).



Use ditch **Detail 6** for the dimensions of the lateral ditch.



Use the previous instructor led exercises as an example. Create a model of the lateral ditch and draft it into the 2D file. Start at the Roadway Designer **Managed Corridors** section. Remember to reload the GPK, RDP, and IRD.

- **Guide**

Roadway Designer – Managed Corridors

Name: LT_L-LAD_097+85-102+00
Type: Alignment
Horizontal Alignment: L
Vertical Alignment: EX_L
Start Station: 97+85.00
Stop Station: 102+00.00

Roadway Designer – Template Drops

Corridor: LT_L-LAD_097+85-102+00
Station: 97+85.00 (interval reset required)
Interval: 50
Template: LT Lateral Ditch with Berm – DDE

Roadway Designer – Parametric Constraints

Constraint Label: DD_Berm Width LT
Start Value: -2
Stop Value: -2

Roadway Designer – Point Controls

Point: LT_DD_Base In_P-CTL-DDE
Mode: Vertical
Control Type: Elevation and Grade
Elevation: 40.00 (U4751_HYD_PSH_S38-PFL.PDF)
Grade: 0.14% (U4751_HYD_PSH_S38-PFL.PDF)

Create Surfaces – Draw 2D Features into DGN File

New Surface for Each Corridor (on)
Empty Design Surface (on)
Features (on)

Ditch Drafting - Linear Pattern

Cycle: Truncated
Pattern: Lateral V Ditch Pattern
Scale: 1

- **Bonus**

Incorporate the ditch model into the cross section (XSC) file

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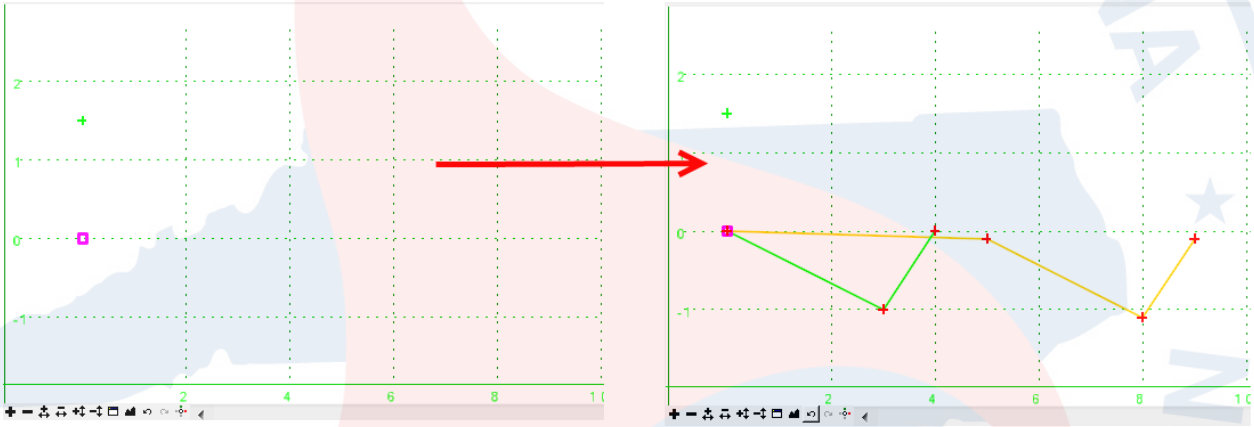
Lateral Transitioning Ditch Series

The design of the lateral transitioning ditch series of templates is to allow engineers to quickly model a series of ditch systems using a single template. Aided greatly by having the ditch grade previously stored electronically in the GPK/ALG, engineers can use point controls to show whether the lateral ditch is DDE (with a berm width) or UCE (extension of Roadway's fill slope). By default both ditch types are turned off (display rule) by having the ditch base point above existing ground. Engineers can use Point Controls to move the inside base point (UCE or DDE ditch) to a ditch grade and specifying a station range to turn on/display the selected ditch.



They are especially suited for transitioning from a UCE to DDE ditch and vice versa. They can also be used on a series of like ditches (non-transitioning).

Working Folder and Files

Folder:
C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Hydro_CMD

Active File:
U4751_HYD_CMD_2D.DGN

RDP:
U4751_HYD.RDP

ITL:
U4751_HYD.ITL

GPK:
HYD

IRD:
U4751_HYD.ITL

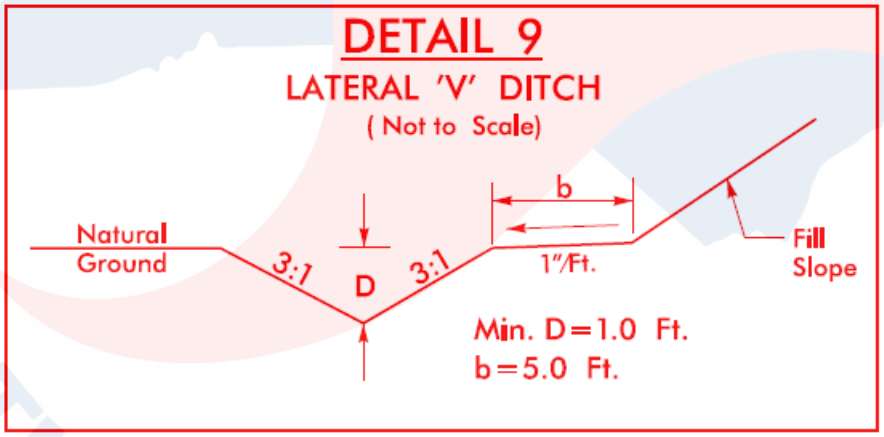
Plan Sheet:
U4751_HYD_PSH_S11.PDF

Profile Sheet:
U4751_HYD_PSH_S38-PFL.PDF

Cross Section File:
CorridorModeling\U4751_RDY_XSC_L.DGN

There are two proposed lateral V ditch by Hydro at the beginning of plan sheet 11 on the right side (blue box).

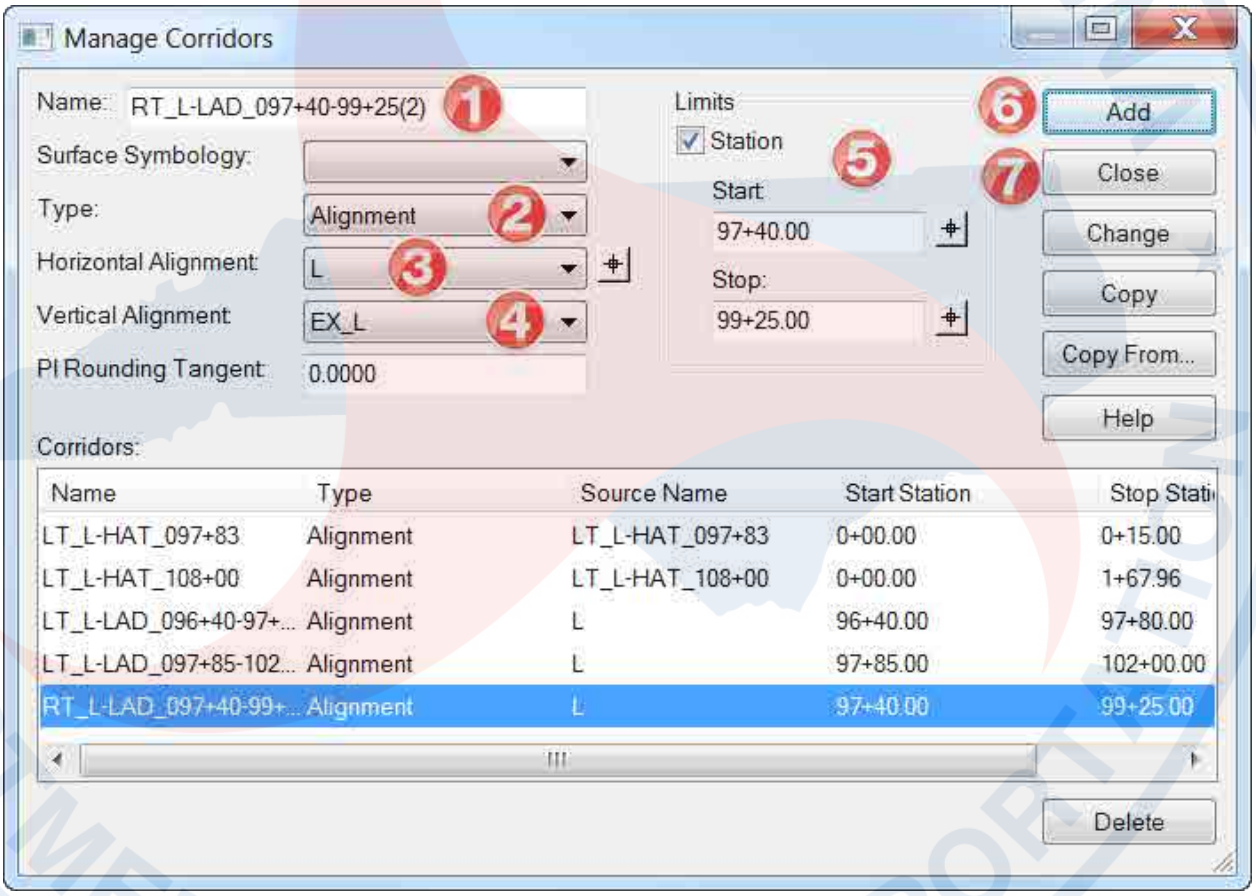
Ditch **Detail 7** and **9** are similar, the difference being the minimum ditch depth (D). Use ditch **Detail 9** for the dimensions of the lateral ditches.



Managed Corridors – Create New Ditch Corridor

1. After loading the U4751_HYD.ird in **Roadway Designer**, create a new corridor in the **Managed Corridors** dialog box with the following settings:

Name: RT_L-LAD_097+40-99+25(2)
Type: Alignment
Horizontal Alignment: L
Vertical Alignment: EX_L
Start Station: 97+40.00
Stop Station: 99+25.00



2. **Save** the IRD file.

Standard Ditch Naming Convention

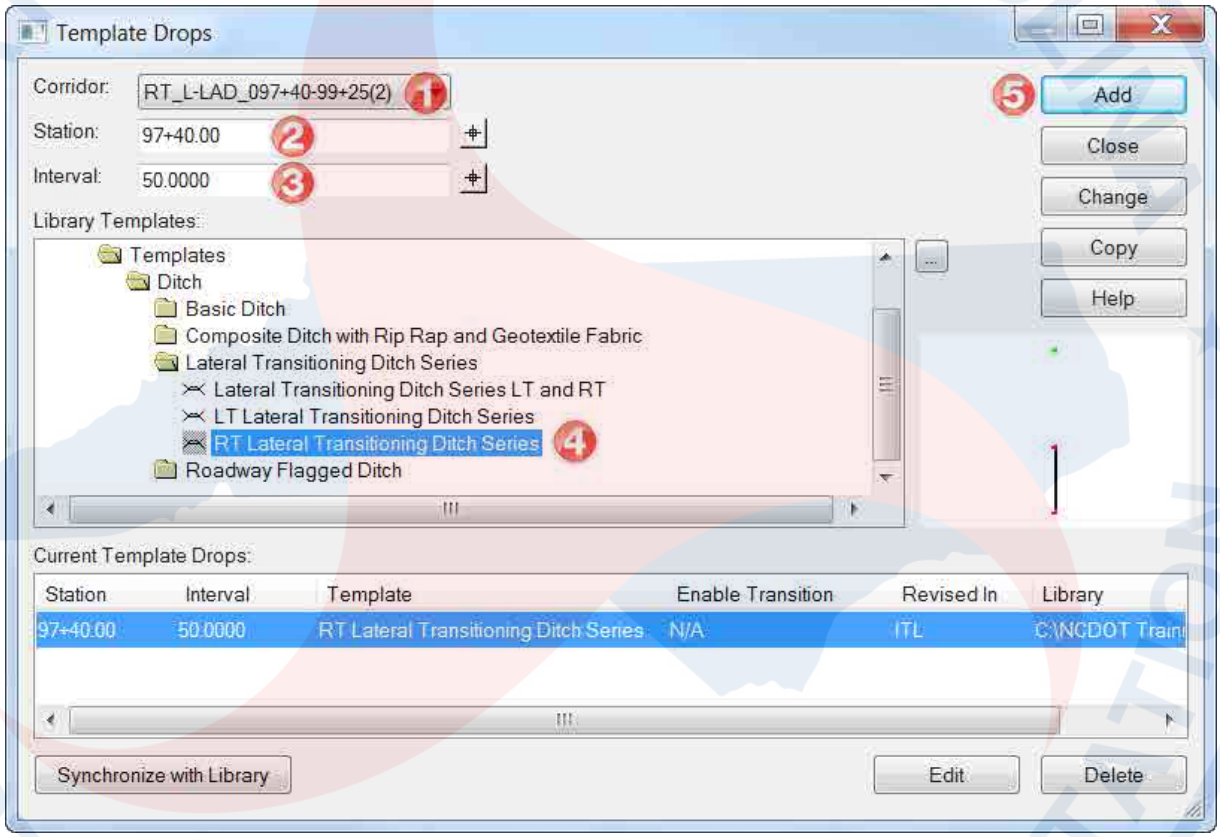
Standard ditch naming convention for multiple lateral ditches in a series should be *LOC_CHA-LAD_BEG STA –END STA(Total Number of Ditch).*

RT_L-LAD_097+83-104+20(2)
LT_Y8-LAD_12+86-30+50(5)
LT_RPA-LAD_18+65-75+60(12)

Template Drops – Corridor Template Selection

3. In the **Roadway Designer Template Drops** dialog box, add the following template drop and settings:

Corridor: RT_L-LAD_097+40-99+25(2)
Station: 97+40
Interval: 50
Library Templates: RT Lateral Transitioning Ditch Series



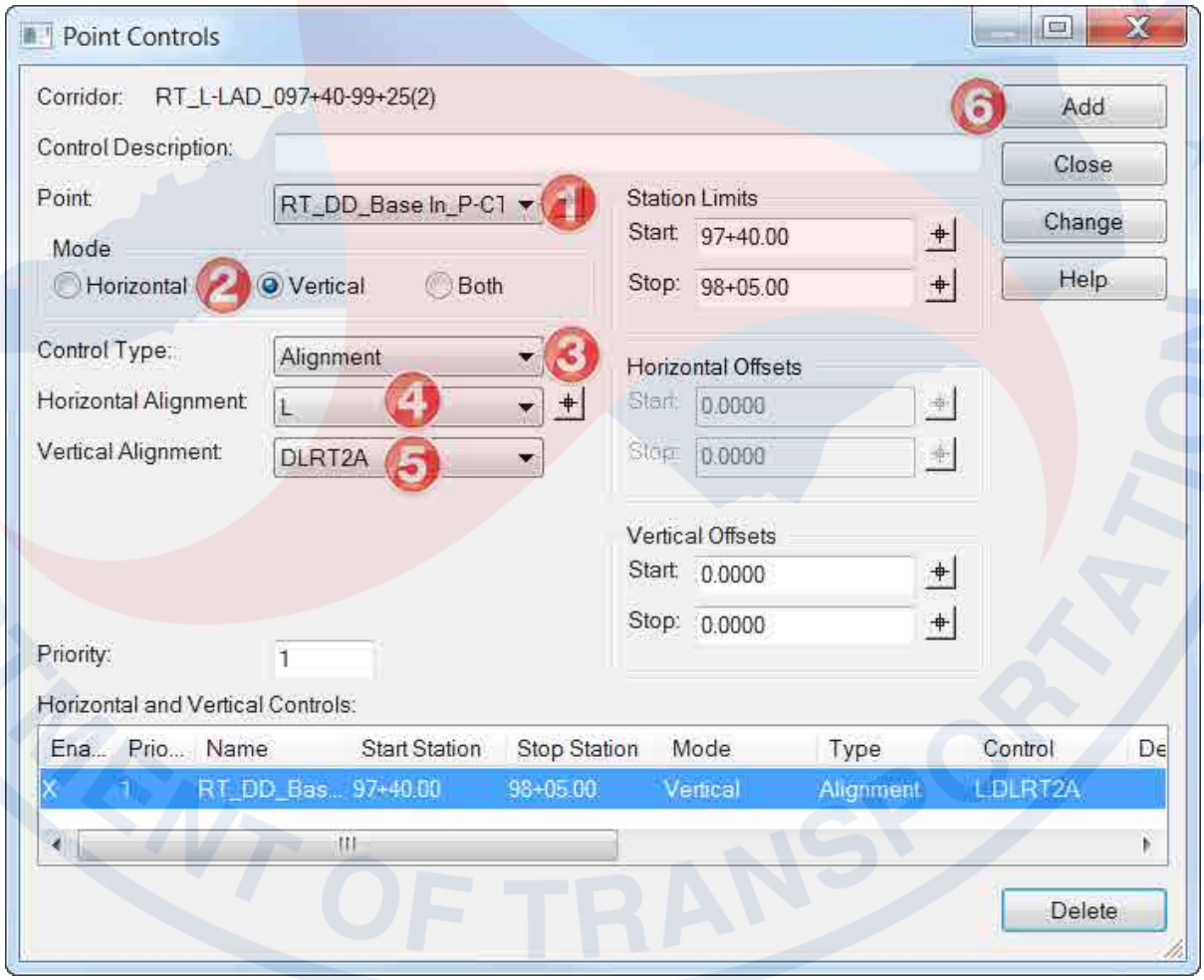
4. **Save** the IRD file.

Point Controls – for Ditch Grade

Ditch components are turned off by default. Point Controls are needed to move the ditch base down to the ditch grade in order for them to be turned on.

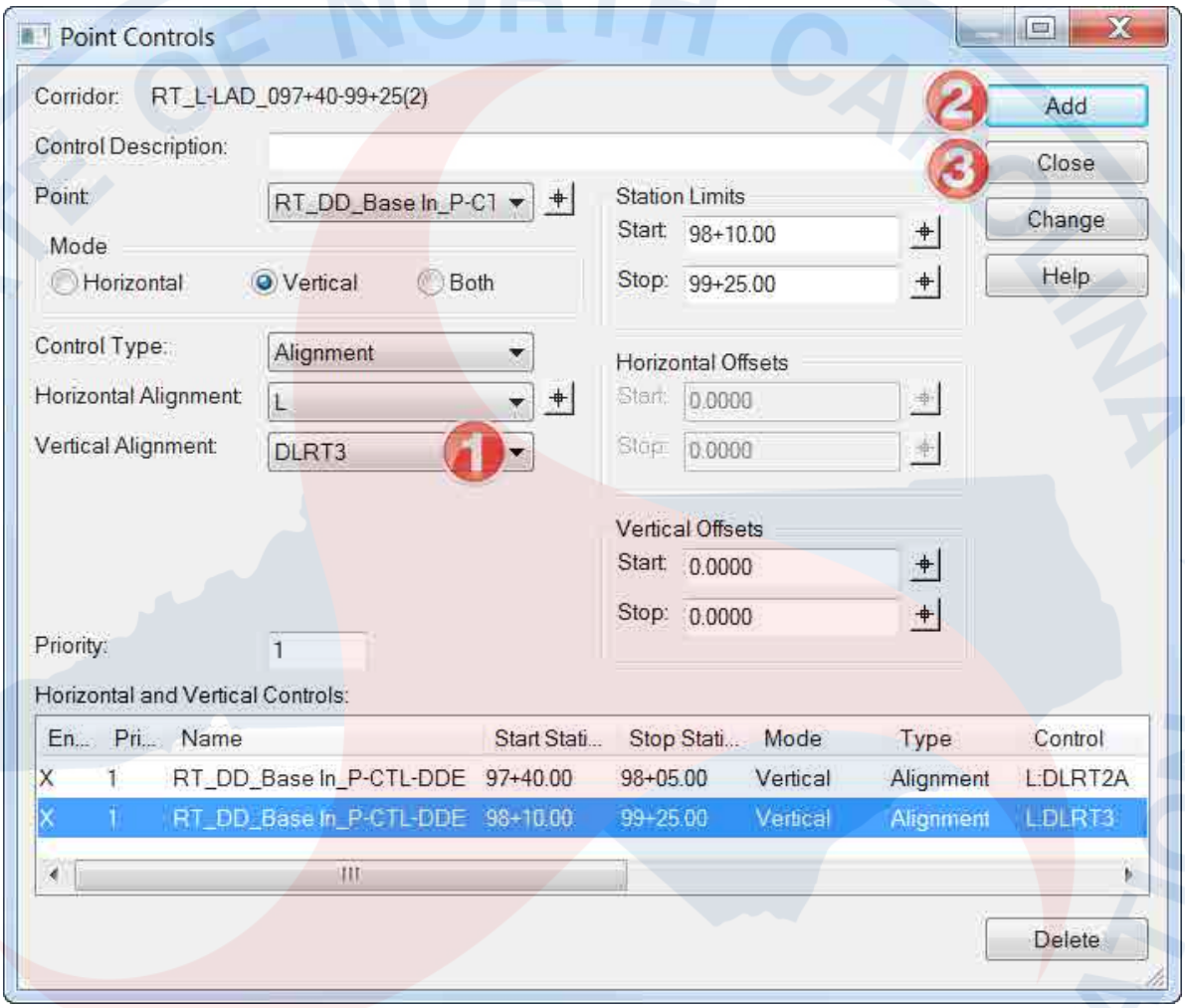
5. In the **Roadway Designer Point Controls** dialog box, add the following point control settings for the **first** ditch grade. Note the **Start** and **Stop Station Limits** are automatically adjusted with the **Vertical Alignment** selection.

Point: RT_DD_Base in_P-CTL-DDE
Mode: Vertical
Control Type: Alignment
Horizontal Alignment: L
Vertical Alignment: DLRT2A



6. **Add** the following point control settings for the **second** ditch grade. Only need to change the **Vertical Alignment** (ditch grade) and the station limits are automatic.

Vertical Alignment: DLRT3



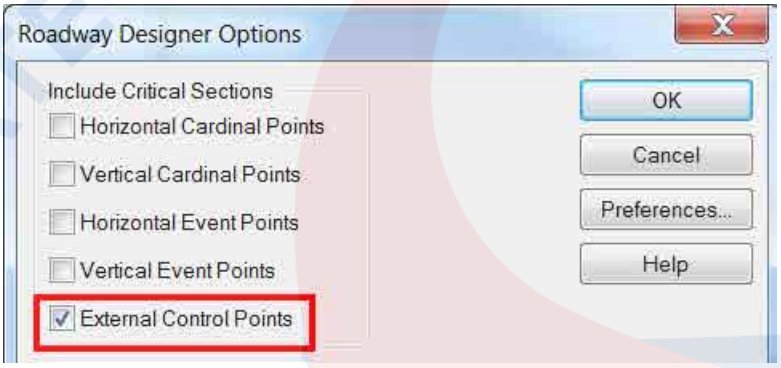
7. **Save** the IRD file.

Which point to choose for point control?

- **RT_DD_Base In_P-CTL-DDE** – ditch with berm width (yellow)
- **RT_DD_Base In_P-CTL-UCE** – ditch without berm width, an extension of fill slope (green)

Creating Gaps and Spacing between Ditches

8. If lateral ditches are not a continuous system, the program will try to create the ditch system as one complete model. To quickly create the necessary gaps and spacing between ditches turn on **External Control Points** (Tools → Options). This will add additional template drops for the station range defined in the **Point Controls** dialog box. It may be necessary to go to the beginning of corridor and click on **Process All** before this takes effect.



Default Roadway Designer Options Preferences

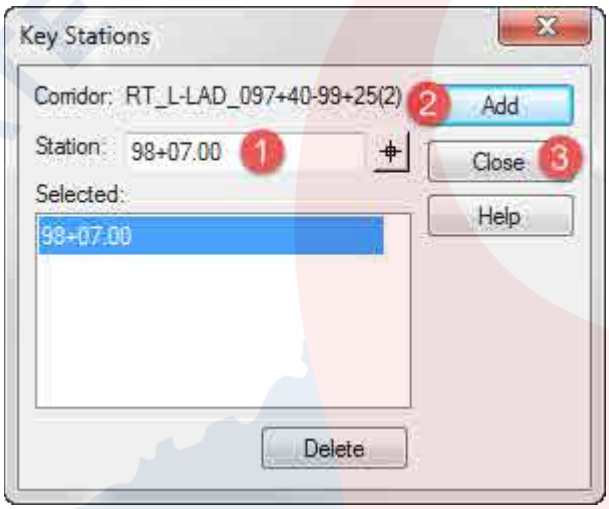
By default the **External Control Points** option is turned off. If it is turned on, then the setting is saved as a resource. Only when the XIN file has been updated or the resource file "rdwizard.rsc" is deleted, will it go back to its default state.

The **External Control Points** option includes other key stations which are not part of the template drop interval. Roadway usually has this option turned off because of the additional template drops, such as superelevation transitions. In the future, it may be beneficial to turn it on as a default.

Some "additional" points at the beginning and ending of the project can be automatically added. An error message resulting from station rounding is normal.

9. If the gap spacing is less than the template drop interval, then additional template drops are needed to turn off the ditch in the area. **Add** an extra template drop in the **Key Stations** dialog box to have at least one template at the off state:

[98+05.00] - end of ditch #1 (on)
98+07.00 – ditch components turned **off**
[98+10.00] - begin of ditch #2 (on)



Blank Template

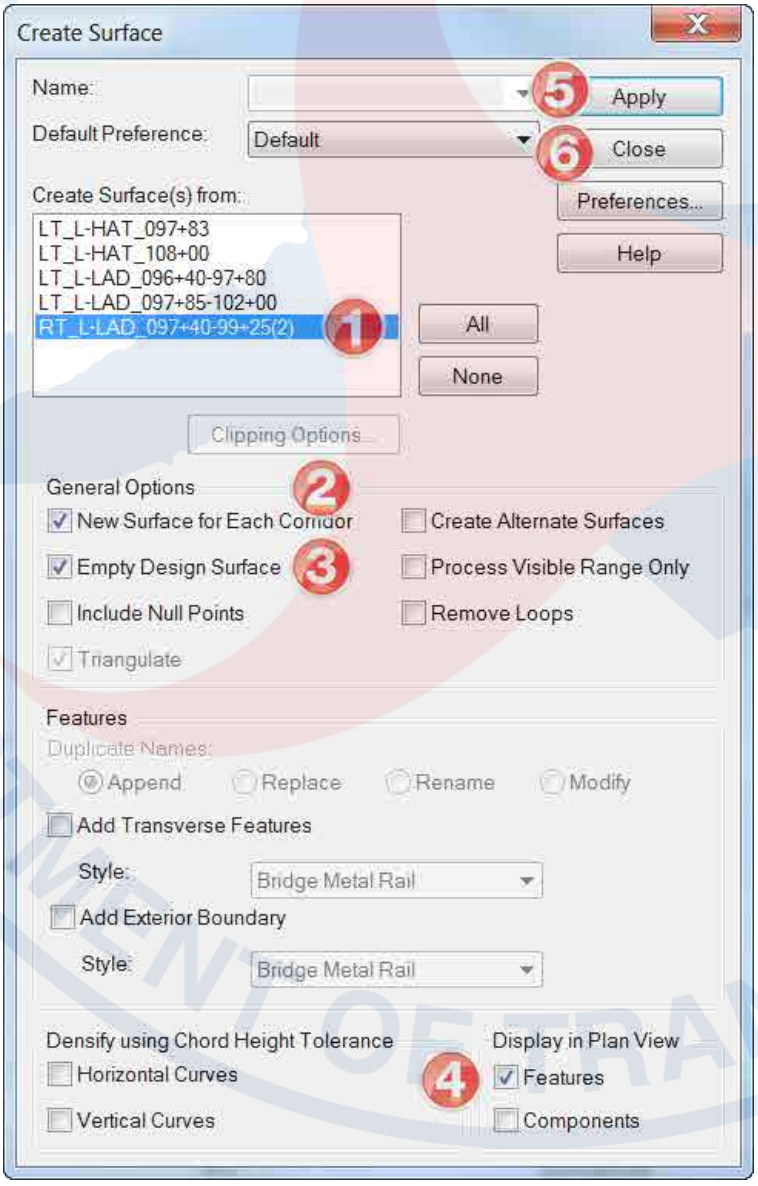
An alternative to Key Stations is to drop “blank templates” in the Template Drops dialog box to create the gap and spacing between ditches.

10. **Process All**.

11. **Save** the IRD file.

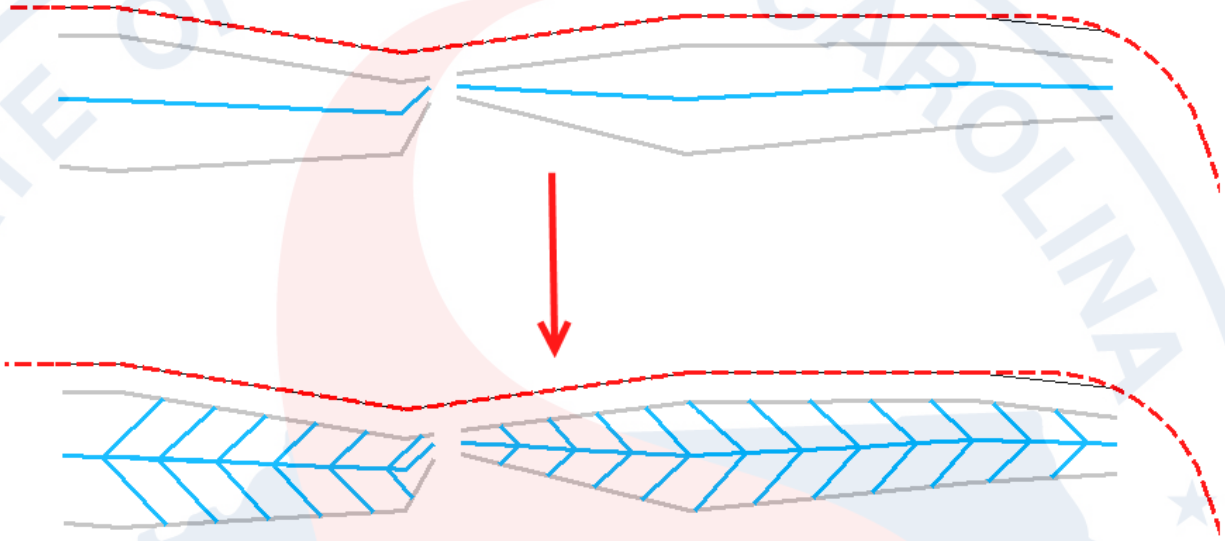
12. In the **Roadway Designer Create Surface** dialog box, create the proposed ditch DTM/TIN with the following settings:

New Surface for Each Corridor (on)
Empty Design Surface (on)
Features (on)



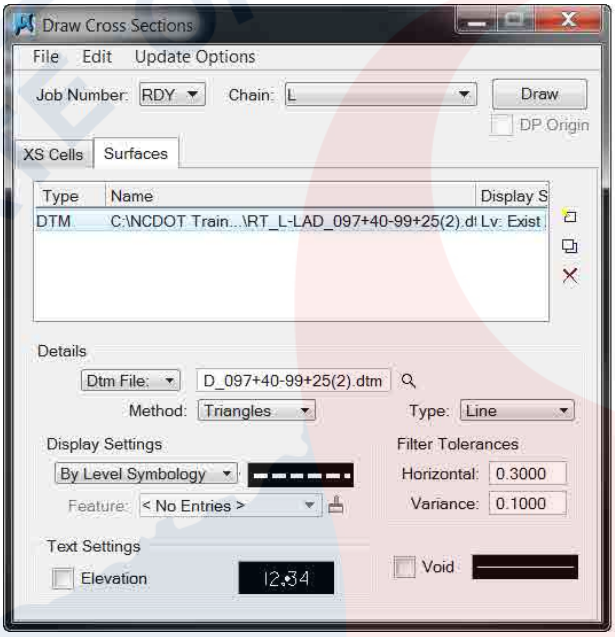
Ditch Drafting in 2D Plan View DGN File - RT_L-LAD_097+40-99+25(2)

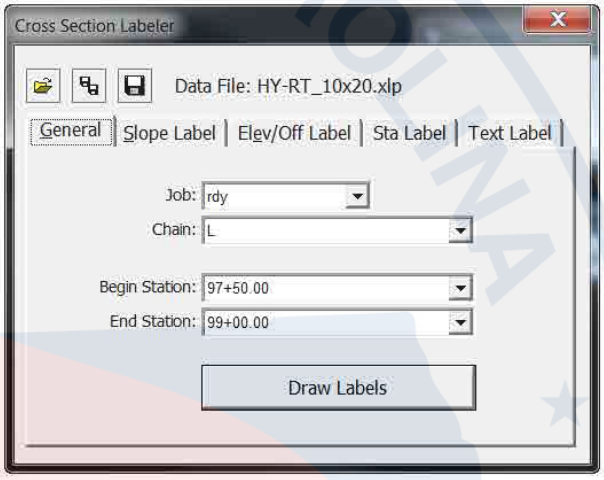
Use the previous lessons on ditch drafting to incorporate the ditch design into the plan sheet.

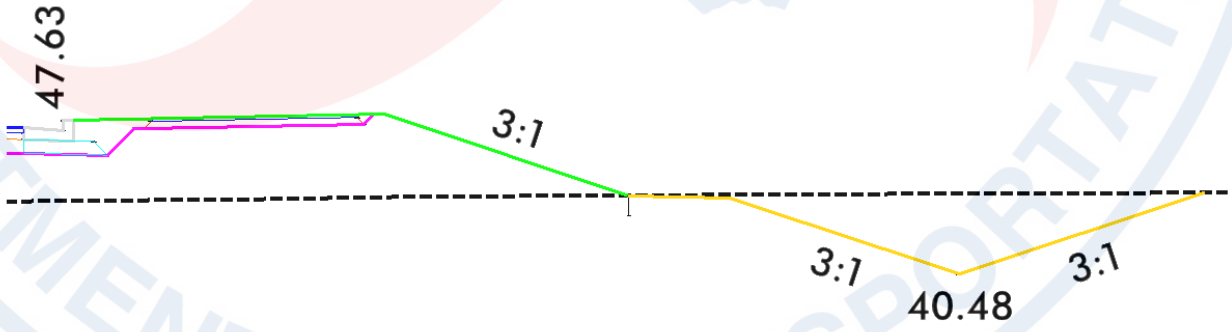


Incorporate Ditch Model into the XSC - RT_L-LAD_097+40-99+25(2)

Use the previous lesson to incorporate the ditch models into the cross section (XSC) file. Use the **HY-RT_10x20.XLP** to label the ditch.







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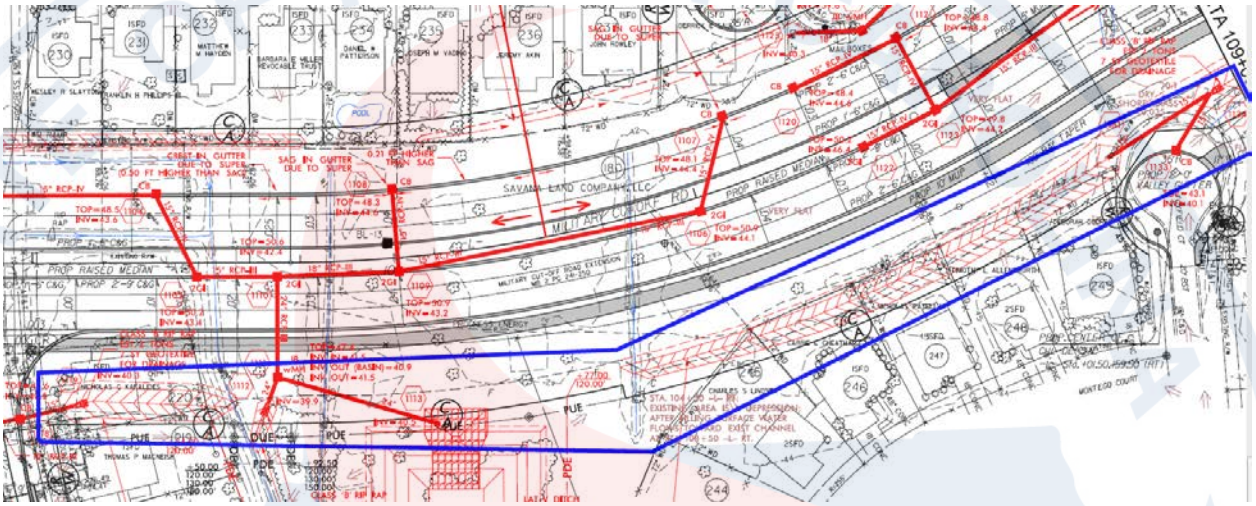
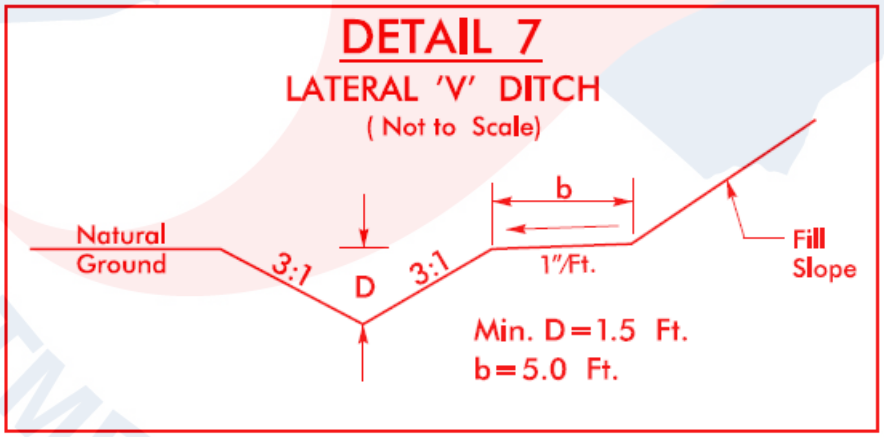
Independent Class Exercise 03 - RT_L-LAD_100+30-110+35(3) (6 min)

There are two proposed lateral V ditch with a 5’ berm by Hydro beginning in the middle of plan sheet 11 (**U4751_HYD_PSH_S11.PDF**) and running to the end of the sheet on the right side (blue polygon).



Use ditch **Detail 7** for the dimensions of the lateral ditches.



Use the previous instructor led exercise as an example. Create a model of the lateral ditches and draft them into the 2D file. Start at the Roadway Designer **Managed Corridors** section. Remember to reload the GPK, RDP, and IRD.

Copy (Corridor) vs. Copy From…

For faster new corridor creation, the **Copy** button in the **Managed Corridors** dialog box copies a corridor in the current .IRD/project and renames it to the new corridor. Adjust the stations and alignments of the new corridor as needed. The formal corridor template drops, point controls, parametric constraints, and other settings are also saved.

The **Copy From** button copies a corridor from another .IRD/project.

- **Guide**

Roadway Designer – Managed Corridors

Name: RT_L-LAD_100+30-109+00(3)
Type: Alignment
Horizontal Alignment: L
Vertical Alignment: EX_L
Start Station: 100+30.00
Stop Station: 109+00.00

Roadway Designer – Template Drops

Corridor: RT_L-LAD_100+30-109+00(3)
Station: 100+30.00 (interval reset required)
Interval: 50
Template: RT Lateral Transitioning Ditch Series

Roadway Designer – Point Controls

Point: RT_DD_Base In_P-CTL-DDE
Mode: Vertical
Control Type: Alignment
Horizontal Alignment: L
Vertical Alignment: DLRT4 (100+30 to 101+50)
Vertical Alignment: DLRT5 (104+25 to 107+75)
Vertical Alignment: DLRT5 (108+75 to 109+00)

Roadway Designer – Options

External Control Points: ON

Roadway Designer – Key Stations

No key stations needed since the lateral ditches are spaced more than the 50' template drops interval.

Create Surfaces – Draw 2D Features into DGN File

New Surface for Each Corridor (on)
Empty Design Surface (on)
Features (on)

Ditch Drafting - Linear Pattern

Cycle: Truncated
Pattern: Lateral V Ditch Pattern
Scale: 1

- **Bonus**

Incorporate the ditch model into the cross section (XSC) file.

There is a ditch grade called **DLRTALL**. Incorporate all five lateral ditches as on corridor.

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Roadway Ditch (ROD)

A lot of research and development have gone into the best practice approach to incorporate roadway ditch into the plans. Based on our knowledge of how templates work, corridor modeling DTM's, roadway designer point controls and targeting corridor features, a complete package has been put together to streamline the process.

Since any ditch change starting from the shoulder point can be classified as a roadway ditch, a ROD model should be used as a "flagged ditch". This is necessary to separate Roadway models from the Hydro ditch models. It is a queue for Roadway engineers to modify their side slopes and ditch grade starting from the shoulder point.

The shoulder point is extracted as 3D surface features from the proposed Roadway DTM. The key is how to obtain this information (puzzling for quite some time.)

Working Folder and Files

Folder:
C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Hydro_CMD

Active File:
U4751_HYD_CMD_2D.DGN

RDP:
U4751_HYD.RDP

ITL:
U4751_HYD.ITL

GPK:
HYD

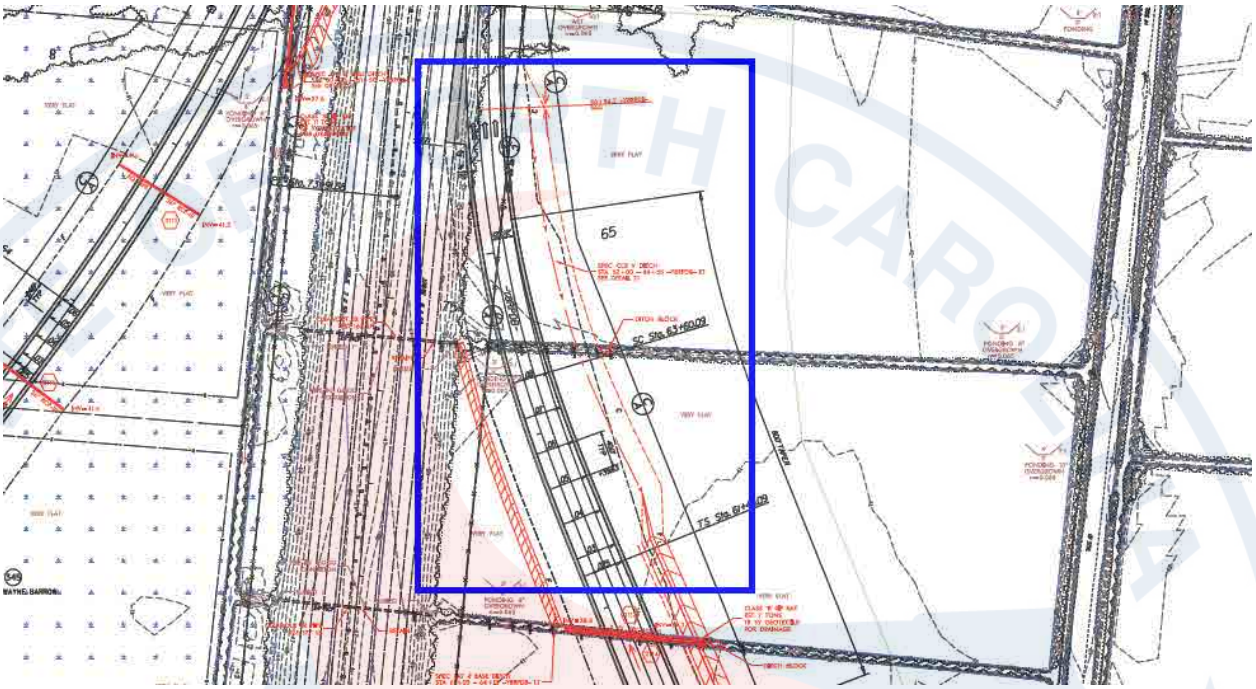
IRD:
U4751_HYD.ITL

Plan Sheet:
U4751_HYD_PSH_S21.PDF

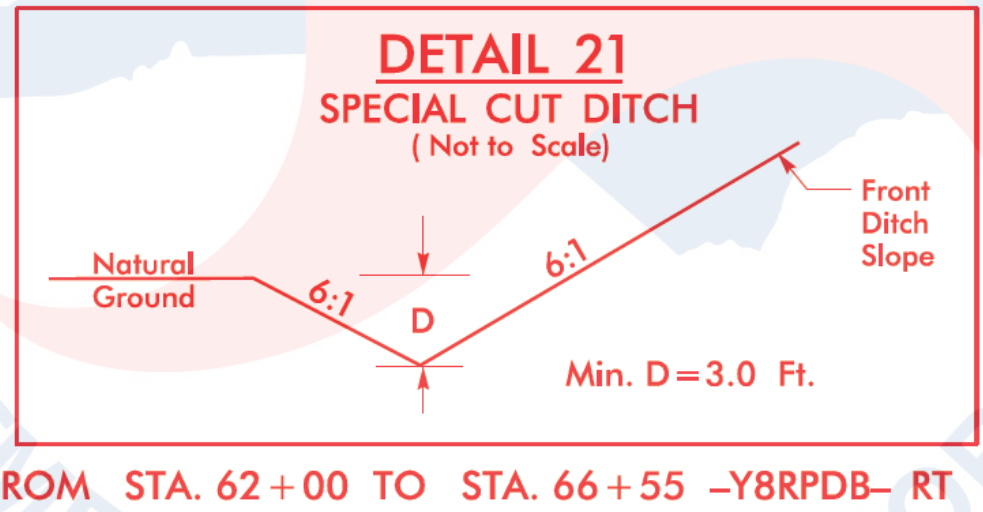
Profile Sheet:
U4751_HYD_PSH_S58-PFL.PDF

Cross Section File:
U4751_Hyd_XSC_Y8RPDB.DGN

There is a proposed modification to a roadway ditch by Hydro at the top of plan sheet 21 on the right side (blue box).



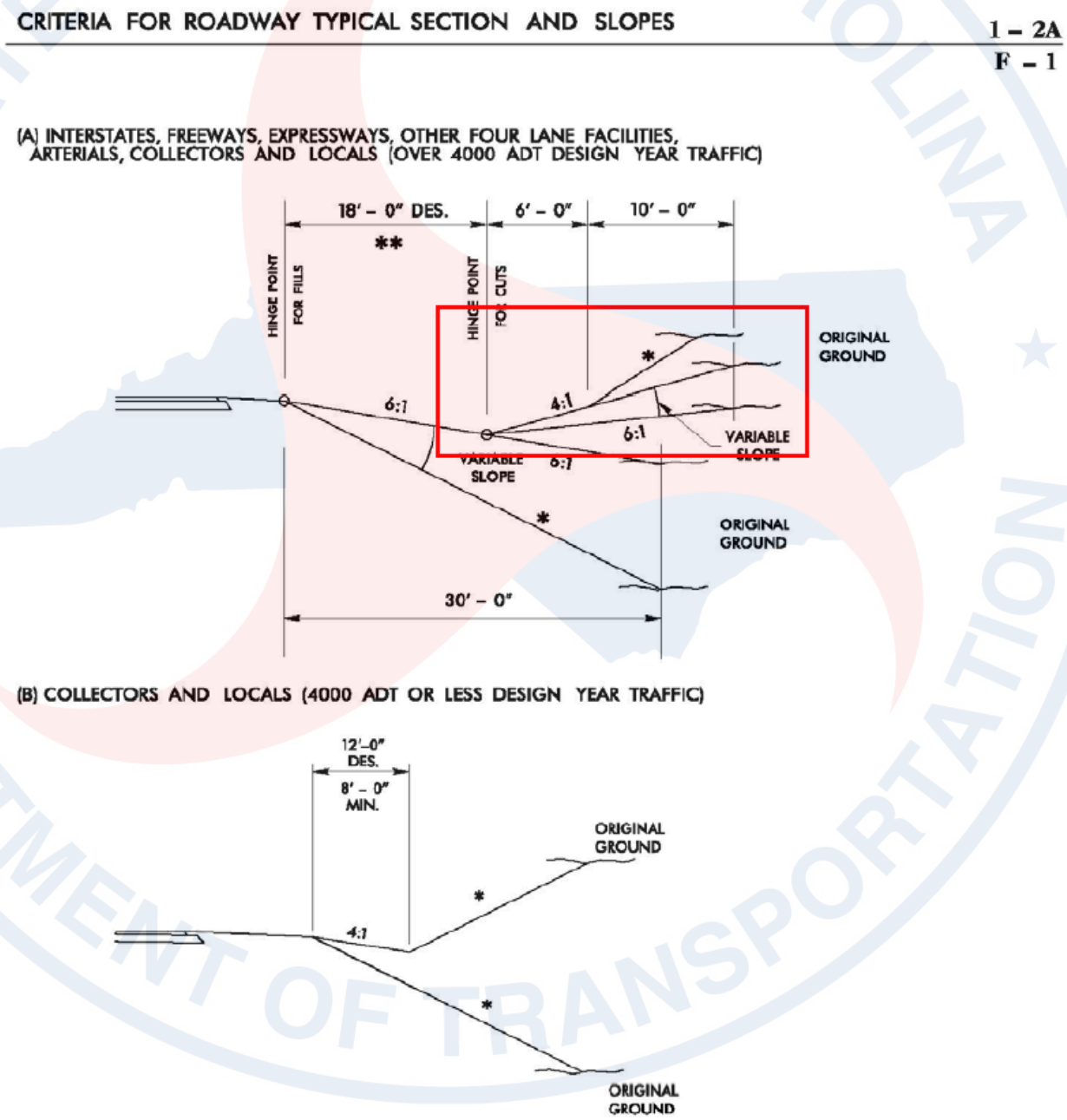
Use ditch **Detail 21** for the dimensions of the roadway ditch.



Roadway Ditch Standard

Freeway and Arterial side slope ditch is based on a cut depth table.

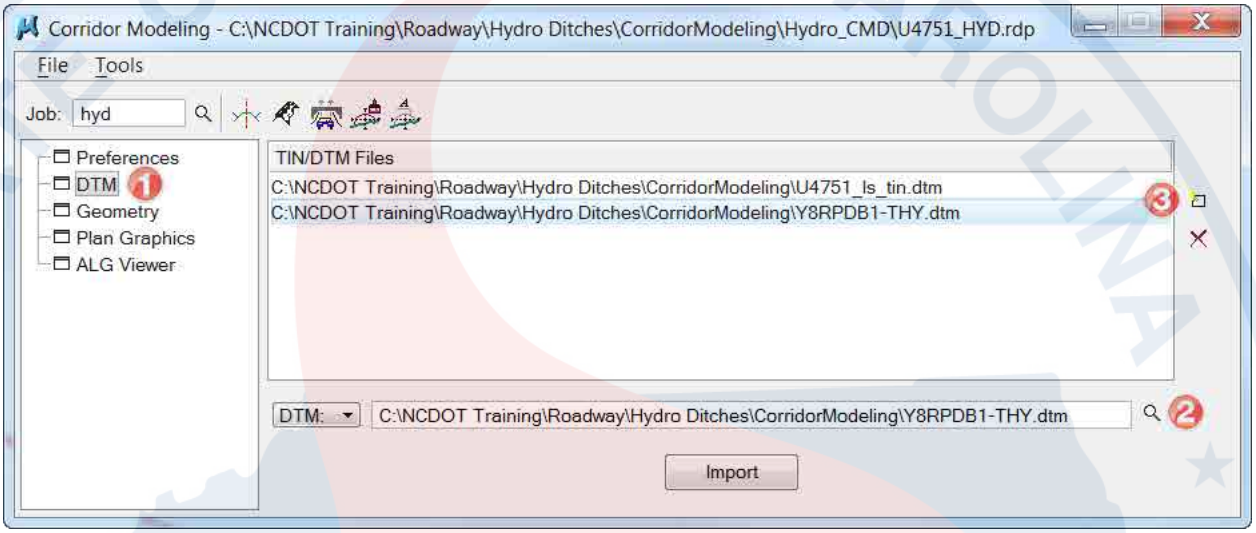
- Ditch depth 0’ to 2.5’, 6:1 for 16’ back slope width.
- Ditch depth 2.5’ to 4’, variable 6:1 to 4:1 for 16’ back slope width.
- Ditch depth greater than 4’, 4:1 for the first 6’ then steepest possible slope (usually 2:1, 3:1 for projects east of I-95).



Corridor Modeling – RT_Y8RPDB-ROD_62+00-66+55

DTM

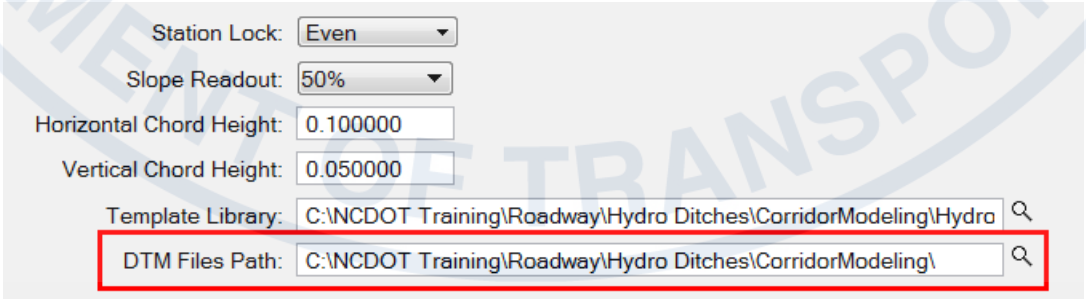
1. After loading the HYD GPK and U4751_HYD.rdp in the Corridor Modeling dialog box, in the **DTM** tab, **add** the Y8RPDB1-THY.dtm to list of surfaces. Remember it is located on folder back. Also since it is already a DTM, no import/conversion is necessary.



2. **Save** the RDP file.

DTM Files Path Influence

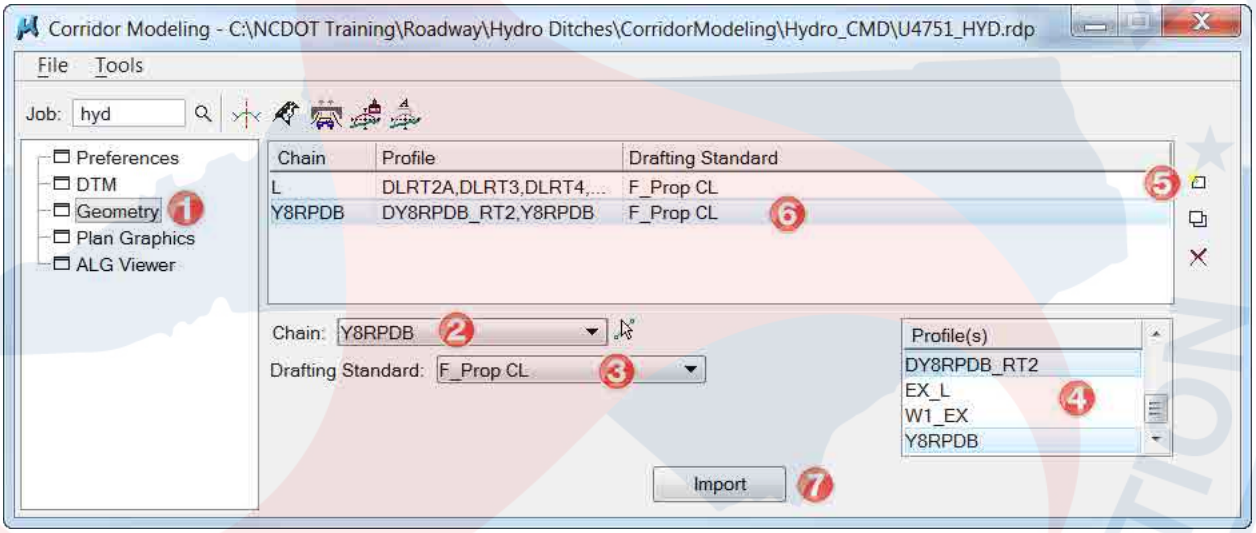
The proposed **DTM** location is in the Roadway CorridorModeling folder. The **DTM Files Path** in the **Preferences** tab must be defined to this folder in order for Roadway Designer to "see" the information in the proposed DTM.



Geometry

3. In the **Geometry** tab, **Import** the Y8RPDB GPK information with the following settings. Hold down the **shift** (range) or **Ctrl** (individual) key to add multiple profiles associated with one chain to the list. **Remember to select and highlight only the Y8RPDB row only before importing the geometry.** If the above **L** row was selected, then only the **L** geometry is updated and the **Update Geometry Reset Bug** is encountered (previously discussed).

Chain: Y8RPDB
Drafting Standard: F_Prop CL
Profile(s): DY8RPDB_RT2, Y8RPDB



4. **Save** the RDP file.

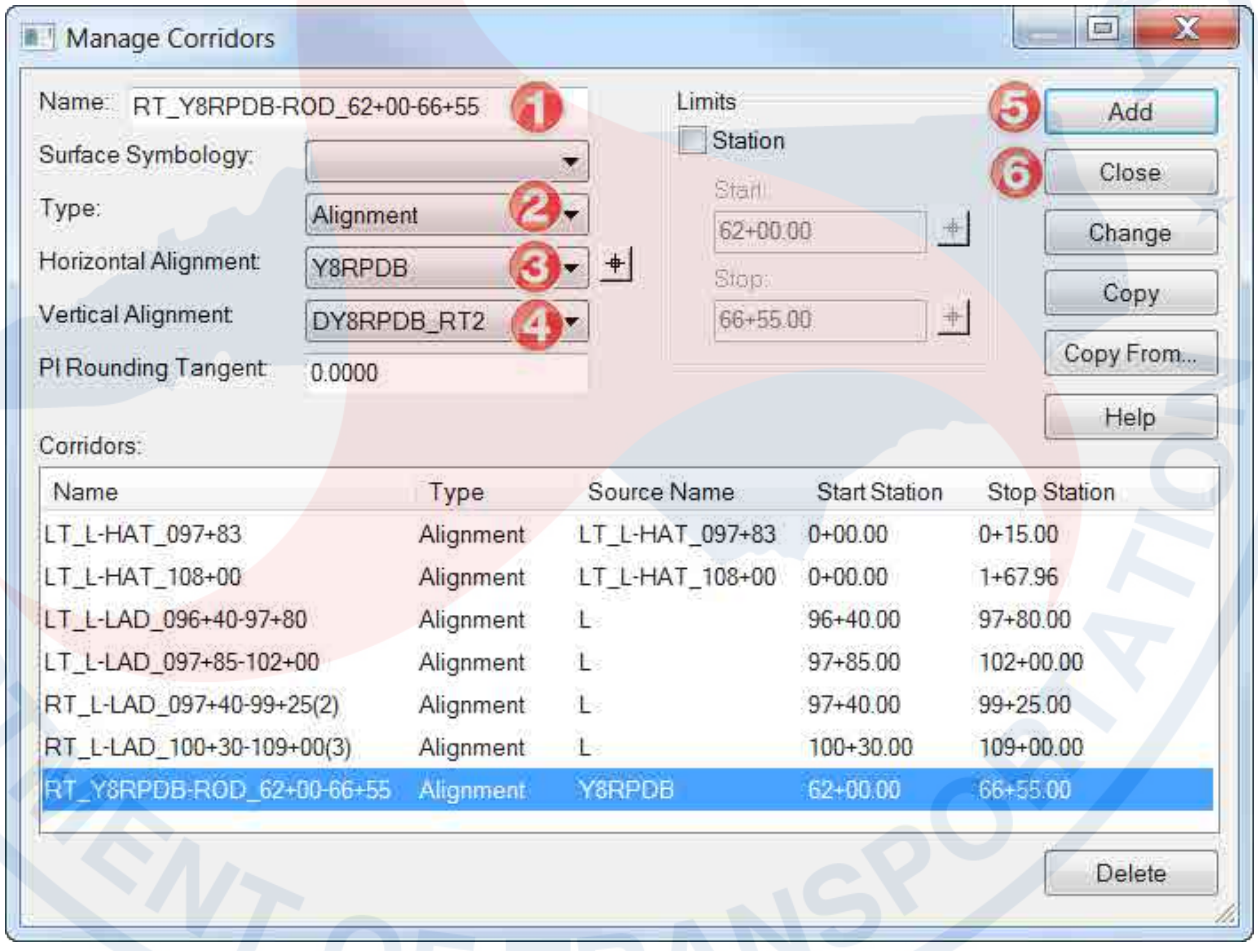
Roadway Designer – RT_Y8RPDB-ROD_62+00-66+55

Managed Corridors – Create New Ditch Corridor

5. After loading the U4751_HYD.ird in **Roadway Designer**, create a new corridor in the **Managed Corridors** dialog box with the following settings:

Name: RT_Y8RPDB-ROD_62+00-66+55
Type: Alignment
Horizontal Alignment: Y8RPDB
Vertical Alignment: DY8RPDB_RT2

Note the station limits are automatically adjusted to the **Vertical Alignment** selection. The **Station Limits** box can be unchecked.

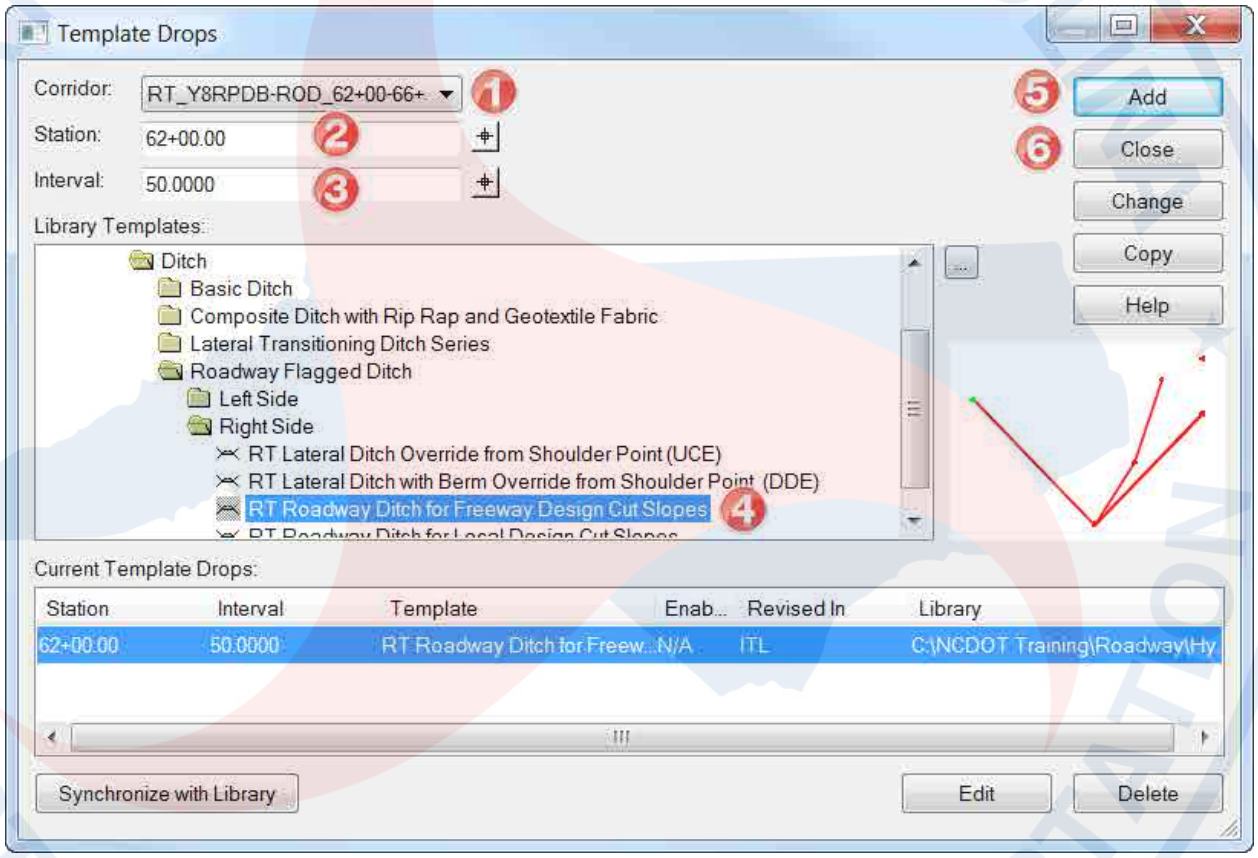


6. **Save** the IRD file.

Template Drops – Corridor Template Selection

7. In the **Roadway Designer Template Drops** dialog box, add the following template drop and settings:

Corridor: RT_Y8RPDB-ROD_62+00-66+55
Station: 62+00.00
Interval: 50
Library Templates: RT Roadway Ditch for Freeway Design Cut Slopes

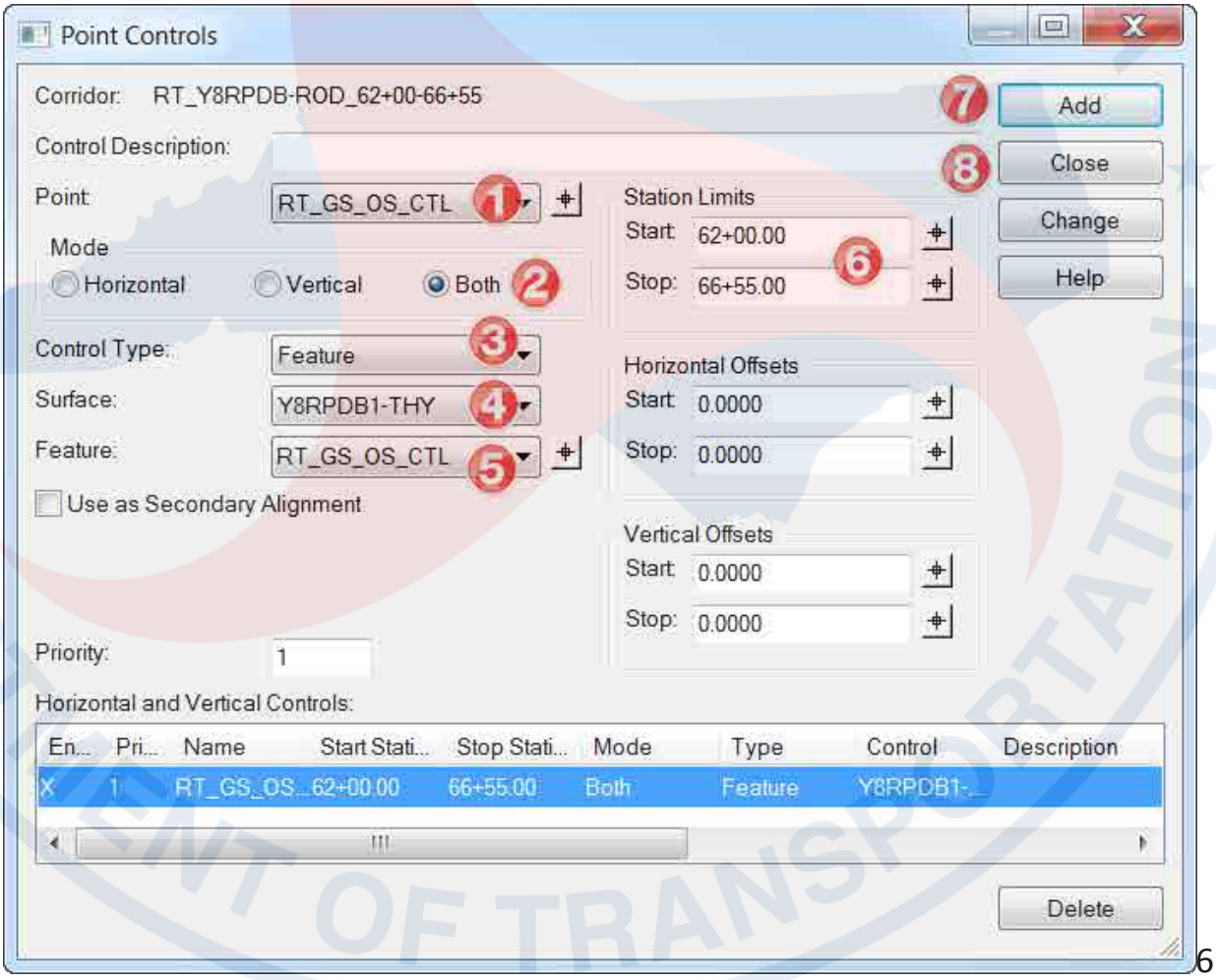


8. **Save** the IRD file.

Point Controls – for roadway shoulder point 3D location

9. The ditch origin or template origin (shoulder point) by default is placed at the **Managed Corridor** horizontal and vertical alignment selection, Y8RPDB and DY8RPDB_RT2 respectively. In the **Roadway Designer Point Controls** dialog box, add the following point control settings to move the ditch orgin point to roadway shoulder point 3D (X, Y, Z) location.

Point: RT_GS_OS_CTL (use point selector button for ease)
Mode: Both
Control Type: Features
Surface : Y8RPDB1-THY
Feature: RT_GS_OS_CTL

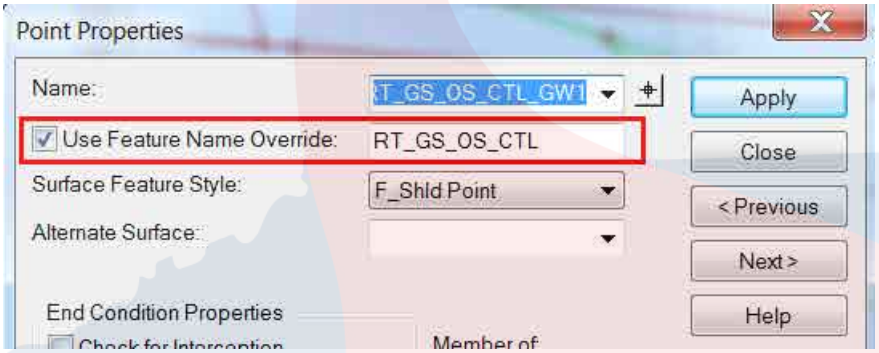


6.

10. **Save** the IRD file.

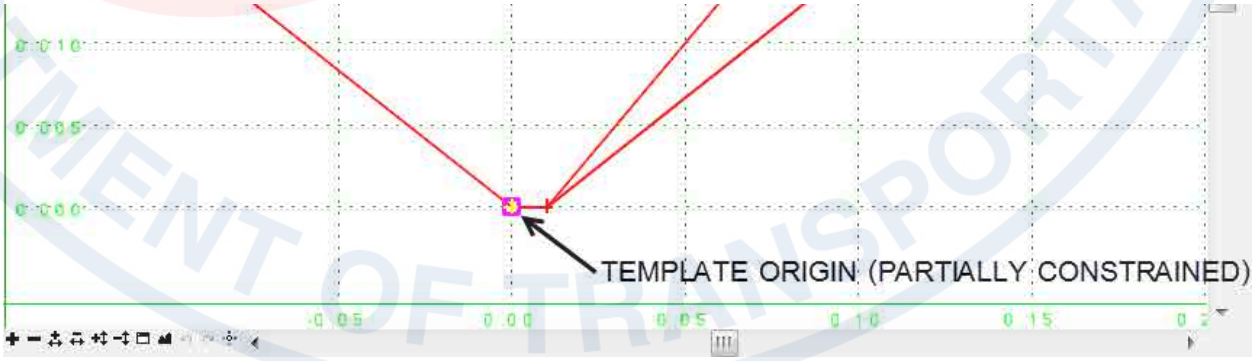
The importance of Feature Name Overrides

Use Feature Name Override set at the Roadway template level (Point Properties) is necessary so multiple points that are used as point control can control one single feature, e.g. normal shoulder point, shoulder point for guardrail graphics, shoulder point for guardrail warrant, etc. would have individual names such as RT_GS_OS_CTL, RT_GS_OS_CTL1, RT_GS_OS_CTL2 instead. It is also beneficial for the **XSlabeler**, one point name instead of three.



Verifying Implied Auto-ditch Grade - Template Configuration Default

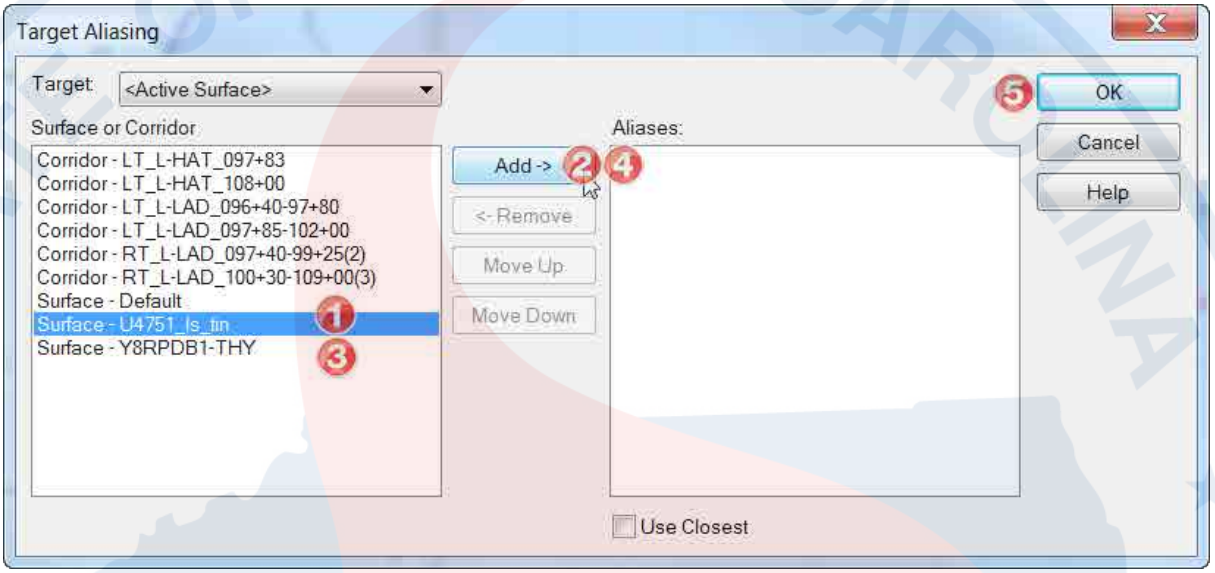
The implied auto-ditch grade works off three criteria; the selection of the **Vertical Alignment** (profile) in the **Managed Corridors** dialog box, changing the template origin point, and the inside ditch base point partially constrained (slope only).

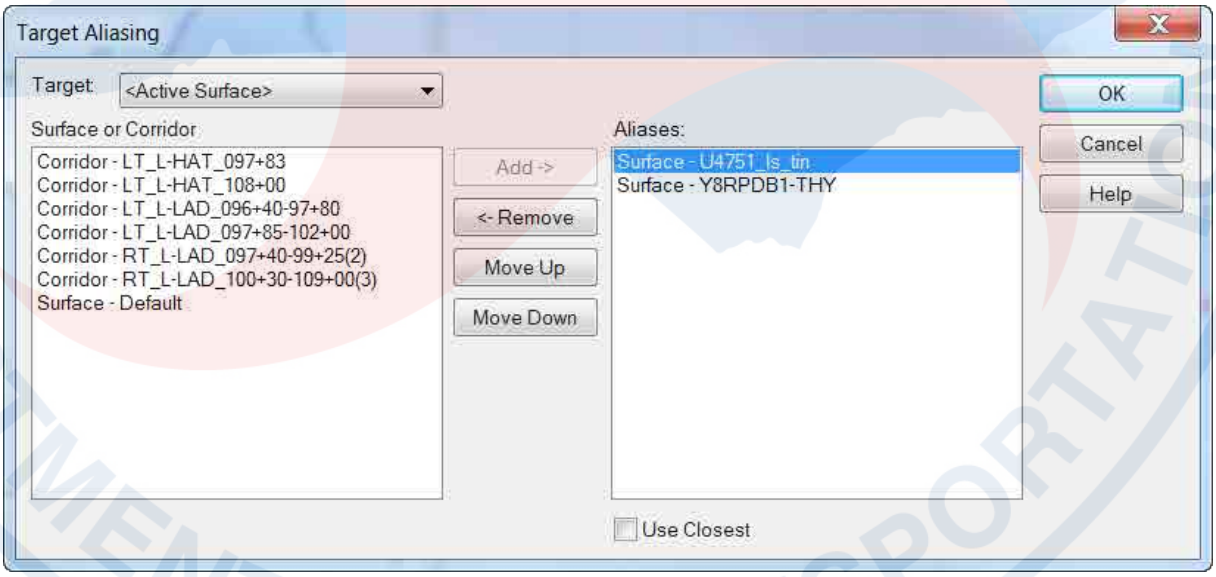


Target Aliasing – Verifying Roadway Shoulder Point

11. Use **Target Aliasing** (Tools → Target Aliasing) to show the surface of the proposed Roadway. **Add** the following surfaces in this order to the **Aliases** list.

1. U4751_ls_tin
2. Y8RPDB1-THY

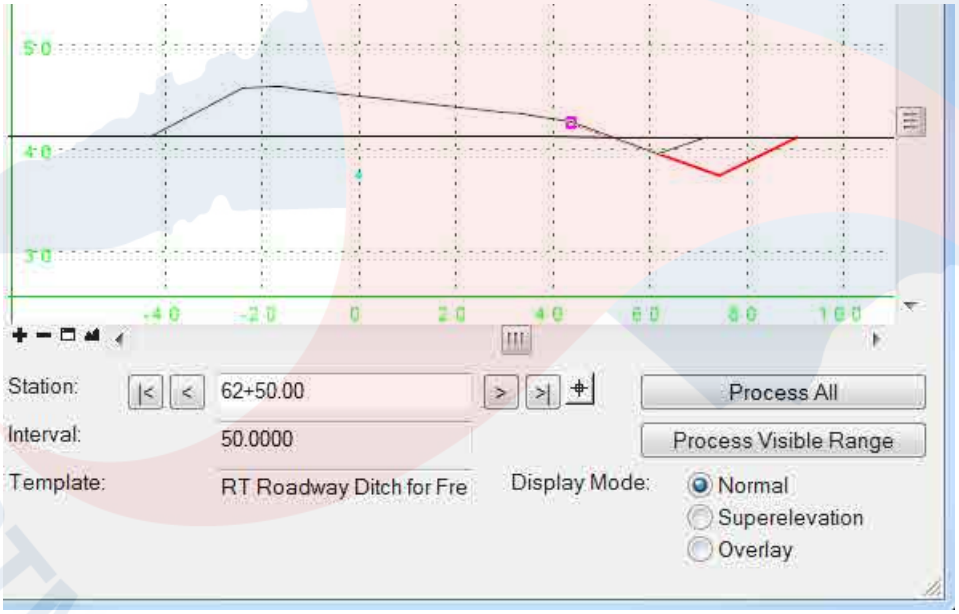




Prioritizing Target Aliasing Surfaces

Normally the active surface is the only surface end conditions are programmed to target. With **Target aliasing**, users can set various surfaces and corridors for the end conditions to target. The first surface or corridor in the list is processed first while the last on the list is processed last. It is especially useful in targeting the side slope of the mainline as you creating the corridor of the ramp (gore area) for example.

12. Go to the next station in **Roadway Designer** and the proposed roadway surface along with the ditch template (red) should be displayed.

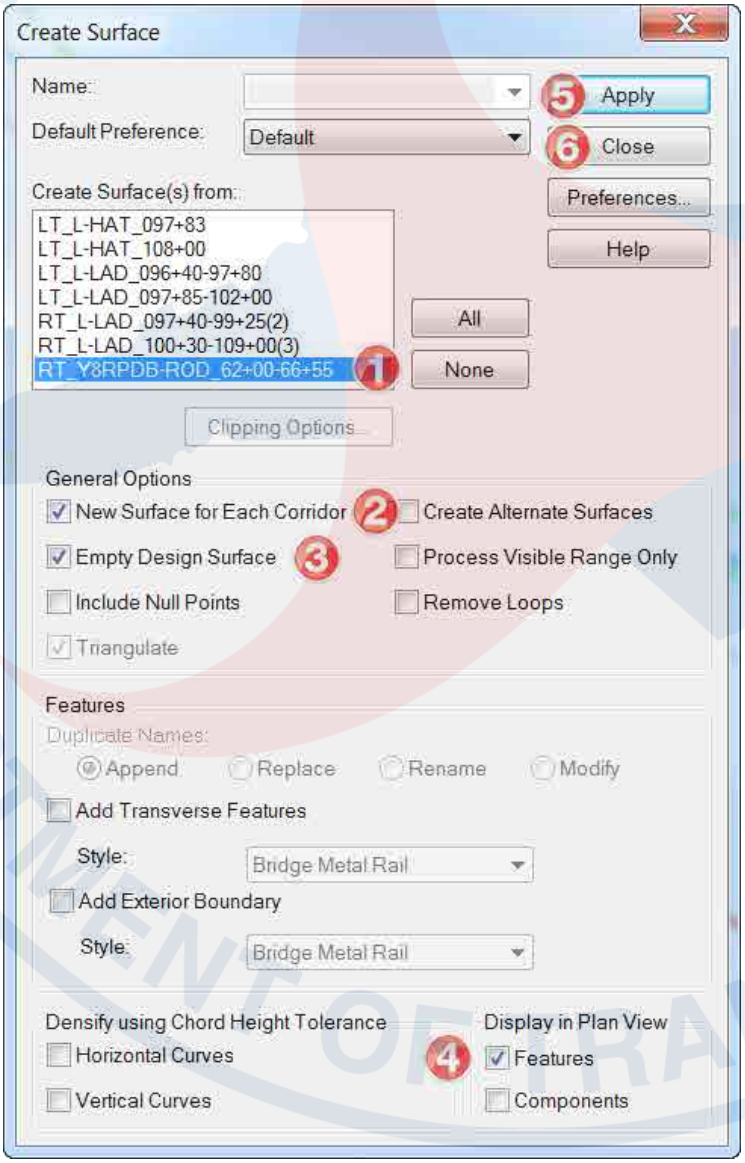


11. **Process All**.

12. **Save** the IRD file.

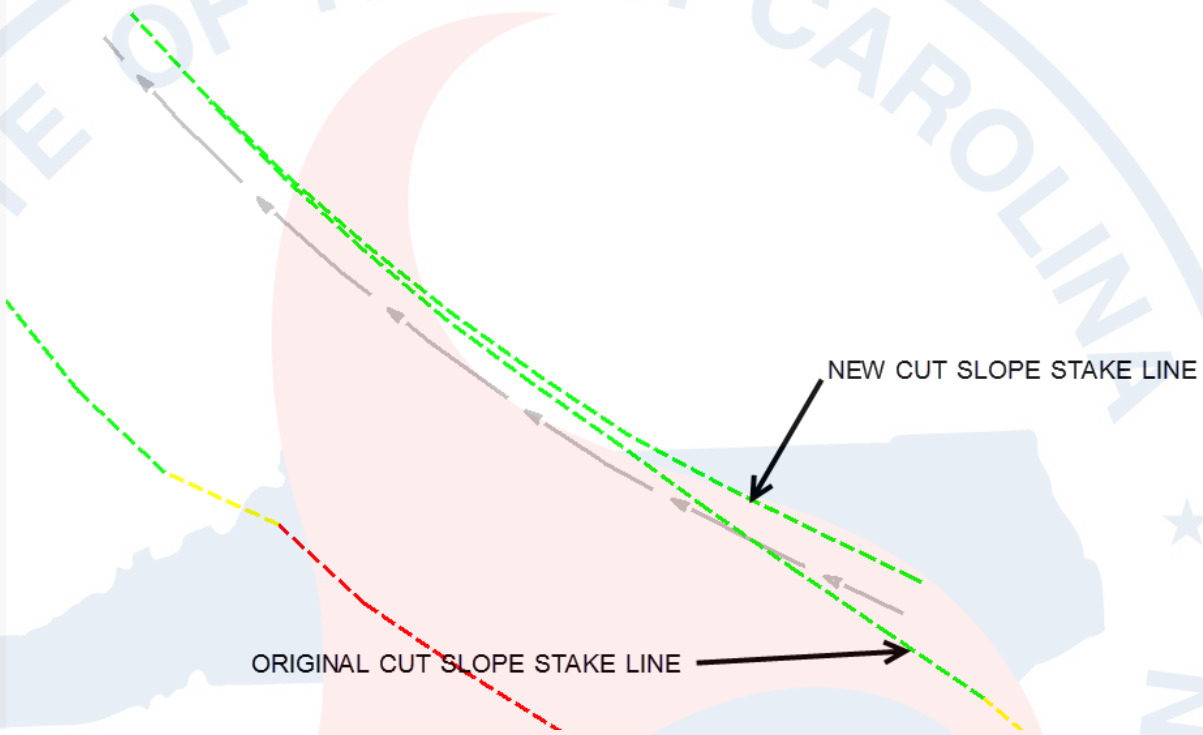
13. In the **Roadway Designer Create Surface** dialog box, create the proposed ditch DTM/TIN with the following settings:

New Surface for Each Corridor (on)
Empty Design Surface (on)
Features (on)



Ditch Drafting in 2D Plan View DGN File - RT_Y8RPDB-ROD_62+00-66+55

Use the previous lesson on UCE ditch to incorporate the ditch design into the plan sheet. Since the ditch is made wide, the cut slope stake is pushed out. Delete the origin slope stake limits in the SS DGN file.



Incorporate Ditch Model into the XSC - RT_Y8RPDB-ROD_62+00-66+55

The proposed roadway and the ditch flag corridors can be incorporated into the cross sections simultaneously. Use the normal roadway **RD_10x20.XLP** and **HY-RT_10x20_Flagged.XLP** to label the ditch. Remember to work off the **U4751_Hyd_XSC_Y8RPDB.DGN** file in the **CorridorModeling** folder, not in the Hydro_CMD folder.