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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.

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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.



#### 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\

ob: hyd 🚺 🔍 🗡	Preferences		
-  DTM - Geometry - Plan Graphics	Station Lock:	Even 3	
- 🗖 ALG Viewer	Slope Readout:	[50% <b>*</b> ]	
	Horizontal Chord Height:	0.100000	
	Vertical Chord Height:	0.050000	-
	Template Library:	oadway\Hydro Ditches\CorridorModeling\Hydro_CMD\U4751_hyd.itl	4
	DTM Files Path:	C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\	
	1		_



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.

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.

Corridor Modeling <u>File T</u> ools Job: hyd Q ~	
Preferences     DTM     Geometry     Plan Graphics     ALG Viewer	IN/DTM Files       C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\U4751_Is_tin.dtm
	DTM: C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\U4751_ls_tin.dtm
. <b>Save</b> the RDP	file.

#### Geometry

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

Preferences     DTM     Geometry     Plan Graphics     ALG Viewer	A A A	rofile	Drafting Standard		
	Chain: L Drafting Standard: F			Profile(s) DLRT2A DLRT3 DLRT4 DLRT5	
			Import		

# 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:

Corridor Modeling								
<u>File T</u> ools								
Job: HYD Q	× & \$\$ \$							
Preferences	Search Criteria	Chain	Side	Beg. Offse Er	nd Offse N	ew Chain	Drafting	Store
DTM.	Group = LT_L-HAT_108+00	Î.	i (	0.00	0.00 L	T_L-HAT_108+00	DNC	E5 C
- 🗖 Geometry								Ę
- ALG Viewer				Ш				× ×
	Selection Set			1	Display			
	Colocion Ser 1			. 6	Disbiol			
				Filt	ter Toleran	ces		
	New Chain Name: LT_L-H/	AT_108+0	0	3) н	lorizontal:	50.00		1
		-			Variance:	0.010000	Inac Inac	too



# 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:

Manage Corridors			
lame: LT_L-HAT_108+00	Limits	6	Add
urface Symbology:	Starl.	6	Close
ype: Alignment 🕗 🚽	0+00.00	-	Change
Iorizontal Alignment: LT_L-HAT_108+00 🚱 +	Stop:		Copy
'ertical Alignment None	1+67.96		
Rounding Tangent 0.0000			Copy From
orridors:			Help
Name Type Source Name	Start Station Sto	p Station	
T_L-HAT_108+00 Alignment LT_L-HAT_108+00	0+00.00 1+67	7.96	

2. Save as U4751\_HYD.IRD.



If the existing profile is available, choose it as the Vertical Alignment. 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)

Control Description Point: Mode O Horizontal	LT_DD_Base In_P	-CT 👻 🕜	Station Li Start 0- Stop: 1-	00.00	) <u>+</u>		Close Change Help
Control Type: Elevation: Grade:	Elevation and Grac 39.3000 -0.25%	le <b>•</b> 3	Horizonta Start 0. Stop 0.	0000	*		
Priority: forizontal and Ver	1 tical Controls:		Vertical C Start 0, Stop: 0	0000	+		
Enabled P Na	me	Start St	Stop Stati	Mode	Туре		Control
< 1 LE.	DD_Base in_P-CTL-DDE	E 0+00.00	1+67.96	Vertical	Elevation and	Grade	39,3000-0.25
	III.	1					K
S					4		Delete



#### **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**  $\rightarrow$  **Options**). Scroll through the sections and the accumulated DDE volume is displayed at the bottom of the cross section view.



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

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)

Name: <ul> <li>Apply</li> </ul> Default Preference: <li>Default</li> <li>Close</li> Create Surface(s) from: <ul> <li>Preferences</li> <li>Help</li> </ul> Alt None    Clipping Options    General Options   Clipping Options   General Options   Process Visible Range Only   Include Null Points   Process Visible Range Only   Include Null Points   Process Visible Range Only   Include Null Points   Propicate Names:   Add Transverse Features   Style:   Bridge Metal Rail   Add Exterior Boundary   Style:   Bridge Metal Rail   Components	Create Surface		×	
Default Preference: Create Surface(s) from: Preferences Help Alt None Clipping Options Clipping Options Clippi	Name:	-	apply	
Create Surface(s) from: T_L-HAT_103+00 Help All None Clipping Options- General Options Clipping Options- General Options Process Visible Range Only New Surface for Each Corridor Process Visible Range Only Process Visible Range Only Process Visible Range Only Process Visible Range Only Remove Loops Triangulate Features Puplicate Names: Add Transverse Features Style: Bridge Metal Rail Clipping Options- Bridge Metal Rail Poensify using Chord Height Tolerance Horizontal Curves Create Alternate Surfaces Process Visible Range Only Remove Loops Display in Plan View Process Visible Range Only Process Visible Range O	Default Preference:	Default		
Image: Style:     Bridge Metal Rail     Style:     Bridge Metal Rail     Densify using Chord Height Tolerance     Display in Plan View	Create Surface(s) fro	m		
All   None   Clipping Options   General Options   Mew Surface for Each Corridor   Process Visible Range Only   Process Visible Range Only   Include Null Points   Include Null Points   Triangulate   Features   Duplicate Names:   Add Transverse Features   Syle:   Bridge Metal Rail   Style:   Bridge Metal Rail   Style:   Bridge Metal Rail   Chorsify using Chord Height Tolerance   Densify using Chord Height Tolerance   Display in Plan View   Prozontal Curves				
None     Clipping Options     General Options     New Surface for Each Corridor     Process Visible Range Only     Process Visible Range Only     Include Null Points     Include Null Points     Remove Loops     Trangulate     Features   Outping Append   Replace   Rename   Modify   Add Transverse Features   Style:   Bridge Metal Rail   Style:   Bridge Metal Rail     Densify using Chord Height Tolerance   Display in Plan View   Horizontal Curves		E I	Неір	
Clipping Options General Options New Surface for Each Corridor Empty Design Surface Empty Design Surface Empty Design Surface Include Null Points Triangulate Features Duplicate Names: Add Transverse Features Style: Bridge Metal Rail Style:		All		
General Options   New Surface for Each Corridor   Empty Design Surface   Empty Design Surface   Include Null Points   Remove Loops   Trangulate     Features   Outplicate Names:   Append   Replace   Rename   Modify   Add Transverse Features   Style:   Bridge Metal Rail   Style:   Bridge Metal Rail   Consify using Chord Height Tolerance   Display in Plan View   Horizontal Curves		None		
General Options   New Surface for Each Corridor   Empty Design Surface   Empty Design Surface   Include Null Points   Remove Loops   Trangulate     Features   Outplicate Names:   Append   Replace   Rename   Modify   Add Transverse Features   Style:   Bridge Metal Rail   Style:   Bridge Metal Rail   Consify using Chord Height Tolerance   Display in Plan View   Horizontal Curves		Clipping Options		
<ul> <li>New Surface for Each Corridor C Create Alternate Surfaces</li> <li>Empty Design Surface C Process Visible Range Only</li> <li>Include Null Points Remove Loops</li> <li>Triangulate</li> </ul> Features <ul> <li>Duplicate Names:</li> <li>Append Replace Rename Modify</li> <li>Add Transverse Features</li> <li>Style: Bridge Metal Rail</li> <li>Style: Bridge Metal Rail</li> <li>Densify using Chord Height Tolerance Display in Plan View</li> <li>Horizontal Curves</li> </ul>		Subbing Obious		
Include Null Points   Triangulate			ate Surfaces	
Include Null Points   Triangulate     Features   Duplicate Names: <ul> <li>Append</li> <li>Replace</li> <li>Rename</li> <li>Modify</li> </ul> Add Transverse Features   Style:   Bridge Metal Rail   Add Exterior Boundary   Style:   Bridge Metal Rail        Densify using Chord Height Tolerance   Display in Plan View   Horizontal Curves     Style:   Display in Plan View				
Trangulate   Features   Duplicate Names:    Append    Add Transverse Features   Style:   Bridge Metal Rail   Add Exterior Boundary   Style:   Bridge Metal Rail   Densify using Chord Height Tolerance   Display in Plan View   Horizontal Curves				
Features   Duplicate Names:    Append    Add Transverse Features   Style:   Bridge Metal Rail   Add Exterior Boundary   Style:   Bridge Metal Rail      Densify using Chord Height Tolerance   Display in Plan View   Horizontal Curves			p	
Duplicate Names:   Append   Add Transverse Features   Style:   Bridge Metal Rail   Add Exterior Boundary   Style:   Bridge Metal Rail	Iv I nanguiate			
<ul> <li>Append Replace Rename Modify</li> <li>Add Transverse Features</li> <li>Style: Bridge Metal Rail</li> <li>Add Exterior Boundary</li> <li>Style: Bridge Metal Rail</li> <li>Densify using Chord Height Tolerance Display in Plan View</li> <li>Horizontal Curves</li> </ul>				
Add Transverse Features Style: Bridge Metal Rail Add Exterior Boundary Style: Bridge Metal Rail Densify using Chord Height Tolerance Horizontal Curves Features Features			Modify	
Style: Bridge Metal Rail   Add Exterior Boundary   Style:   Bridge Metal Rail   Densify using Chord Height Tolerance Display in Plan View Horizontal Curves Features				
Image Metal Rail     Style:     Bridge Metal Rail     Densify using Chord Height Tolerance     Display in Plan View     Horizontal Curves     Image: Provide Height Tolerance     Display in Plan View				
Style: Bridge Metal Rail   Densify using Chord Height Tolerance Display in Plan View Horizontal Curves		<u>1. 15</u> 21		
Densify using Chord Height Tolerance Display in Plan View Horizontal Curves		57 		
Horizontal Curves	oure.	Bridge Metal Rall		
	Densify using Chor	rd Height Tolerance Displa	y in Plan View	
Vertical Curves Components	Horizontal Curv	es 🛛 🕜 🗹 Fea	atures	
	Vertical Curves	Cor	mponents	

# 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.

DITCH BOUNDARY	DITCH CENTERLINE (BLUE)
DITCH BASE	
	DITCH BASE
	DITCH BOUNDARY
	<u>A</u>

#### 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.

	📕 Cell Library: [\cell\roadv	way_english_hydraulic.cel]	
	File 🔞		
	Use Shared Cells	Display All Cells In Path	Display: Wireframe
S Linear Pattern	Name	Description	
Cycle       Truncated       Image: Cycle         Pattern:       Lateral V Ditcl       Image: Cycle         Scale:       1.00000       Image: Cycle         Tolerance:       0.0000       Image: Cycle         True       Scale       Scale	Lateral 5ft Base Ditch Patter Lateral 6ft Base Ditch Patter Lateral 6ft Base Ditch Patter Lateral 6ft Base Ditch Patter Lateral V Ditch Pattern Outs Lateral V Ditch Pattern Outs Lateral V Ditch Pattern Outs Active Cells Placement Lateral 6ft Terminator NONE	n Roadway Lateral 6 n Outside n Outside Reflect de de Reflect	Edit Delete Create Share

# **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.

TAIL DITCH	
Linear Pattern	
Cycle       Truncated       ▼         Pattern:       Lateral V Ditch       Scale:         Scale:       1.00000       0.0000         Tolerance:       0.0000       True Scale	
	and a second and a second a se
	14
e the ditch chevrons took on	

# 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 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.



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

IntelliTrim

Mode Quick

Operation Extend 💌

+

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

# DRTH CA **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 reevaluating 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

Corridor Modeling			X
<u>File</u> <u>T</u> ools			
Job: hyd Q >	× A 🛱 🚔 🌲		
Preferences	Chain Profile Drafting Sta	andard	
	L DLRT2A,DLRT3,DLRT4,DLRT5,DLRTALL,EX_L F_Prop CL		-6) -
-□ <u>Geometry</u>			×
- ALG Viewer			^
	Chain: L	Profile(s)	
		DLRT2A	
	Drafting Standard: F_Prop CL Ctrl or Shift +	DLRT3	
	Cut of Shint +	DLRT4	
		DLRT5	*
	Import 6		

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





#### **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.

Chain	Side	Beg. Offse	End Offse	New Chain	Drafting \$	Store
L	Left	0.00	150.00	LT_L-SS	T_DD	
		0.00	0.00	LT_L-HAT	DNC	
		0.00	0.00	LT_L-HAT	DNC	
		111				
	_					
	Chain		L Left 0.00 0.00 0.00	L Left 0.00 150.00 0.00 0.00 0.00 0.00	L         Left         0.00         150.00         LT_L-SS           0.00         0.00         LT_L-HAT           0.00         0.00         LT_L-HAT	L         Left         0.00         150.00         LT_L-SS         T_DD           0.00         0.00         0.00         LT_L-HAT         DNC           0.00         0.00         0.00         LT_L-HAT         DNC

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

ile <u>T</u> ools b: HYD Q	***							-	
Preferences	Search Criteria	Chain	Side	Beg. Offse	End Offs	e New Chain	Drafting	S Store	1
DTM	Group = LT L-HAT 108+00	0	Î.	0.00	0.00	LT L-HAT 108+00	DNC		<b>)</b> ē
Geometry	Group = LT_L-HAT_097+83			0.00	0.00	LT_L-HAT_097+83	DNC		1 ç
Plan Graphics	Group = RT_L-SS	li	1	0.00	0.00	RT_L-SS	T_DD	v (5)	
ALG Viewer	Group = LT_L-SS			0.00	0.00	LT_L-SS	T_DD		>
	Selection Set 🔹 🕗				[ [	Display			_1
	New Chain Name: RT_L-S	s 🧖	<u> </u>	-1		Tolerances ontal: 50.00			

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

orizontal Alignm	ent: L				
ertical Alignment	t: EX_L				
art Station: 96+4	40.00				
op Station: 97+8	80.00				
Manage Corridors					
Name: LT_L-LAD_096+4	40-97+80 🎧	10 M	imits	6	Add
Surface Symbology:		•	Station		Close
Туре:	Alignment	2 +	Start VS	▲ ₩	
Horizontal Alignment:	L	* +	Stop:		Change
Vertical Alignment	EX_L	4 -	97+80.00	+	Сору
PI Rounding Tangent	0.0000				Copy From
Corridors:					Help
Name	Type	Source Name	Start Station	Stop Station	
LT_L-HAT_097+83	Alignment	LT_L-HAT_097+8:	3 0+00.00	0+15.00	
LT_L-HAT_108+00	Alignment	LT_L-HAT_108+00	0 0+00.00	1+67.96	
LT_L-LAD_096+40-97+80	Alignment		96+40.00	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.

Corridor: L1_L-LA	D_096+40-97+80		3	Add			
Display Reference				Contraction of the local distance of the loc			
	.T_L-SS	<b>▼ +</b>	- C -	Close			
Surface:	J4751_ls_tin	*		Change			
Feature:		+ +		Help			
Filter:	Unnamed>	*					
🔽 Display as Rig							
Limits	<b>_</b>						
Station							
	0+00.00						
1	61+70.96	+					
4							
Display References	a						
	Name	Right of	Way :	Start Station			
Alignment	LT_L-SS	True					
*	40						
-			-	8.77.			
				Delete			
	<u> </u>				ļ		
	<u> </u>				ļ		
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+6				Delete	* 1933011. 2000010. 2000010.		
**				Delete			
+4							
+6 +2							
4 6 · · · · · · · · · · · · · · · · · ·			8 5				

#### **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)

Point Controls			
Corridor: LT_L-LAD_0	96+40-97+80		Add
Control Description:			Close
Point	T_DD_Base In_P-CT	Station Limits	
Mode 🦱		Start: 96+40.00	Change
Horizonta 🕗 🧿	Vertical 🔘 Both	Stop: 97+80.00	+ Help
Control Type:	Elevation and Grade 🔹	Horizontal Offsets	
Elevation:	1.3000	Start: 0.0000	
Grade	0.93% 3	Stop: 0.0000	
		Vertical Offsets	
		Start 0.0000	
		Stop: 0,0000	
Priority:			
Horizontal and Vertical C	ontrols:		
E P Name		Stop St., Mode Type	Control Des
X 1 LT_DD_Base	In_P-CTL-UCE 96+40.00 9	7+80.00 Vertical Elevation a	nd Grade 41.3000:-0.93
	UI.		N N
			Delete
			Delet

## 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)



N.C. Dept. of Transportation | Incorporating Hydraulics Ditch Designs

# Ditch Drafting in 2D Plan View DGN File - LT\_L-LAD\_096+40-97+80

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.

	M Draw Cross Sections			
	File Edit Update Option	IS		
	Job Number: RDY - Cl	nain: L	Draw	
	XS Cells Grfaces		DP Origin	*
	Pattern			
	In Existing Only	2		
	Scale	Spacing		
	Horizontal: 10.00000	Horizontal:	1000.000	
	Vertical: 10.00000	Vertical:		
		Number of XS by Column:		
		r TOA	N	
Ĺ		THAT		)

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.

File Edit Update Options	
Job Number: RDY 🔻 Chain: L	Traw 5
	DP Origin
S Cells Surfaces	
Type Name	Display Settings
DTM C:\NC\LT_L-LAD_096+40-	-97+80.dtm Lv: Exist XS Gro
	×
Details	
Dtm File: - LAD_096+40-9	97+80.dtm Q
Method: Triangles	Type: Line
Display Settings	Filter Tolerances
By Level Symbology	Horizontal: 0.3000
Feature: < No Entries >	Variance: 0.1000
Text Settings	Void
Elevation 12,34	



## **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\_Modelin g\XS\_Labeler).

Image: Begin Station:   96+00.00   End Station:   97+50.00   Draw Labels	Cross Section Labeler
Job: rdy Chain: L Begin Station: 96+00.00 End Station: 97+50.00 3	Data File: HY-LT_10x20.xlp
Chain:       L       Chain:       Image: Chain Cha	Peral Slope Label Elev/Off Label Sta Label Text Label
Begin Station: 96+00.00 4 End Station: 97+50.00 5	
End Station: 97+50.00	Chain: L
	Begin Station: 96+00.00
Draw Labels 🔞	End Station: 97+50.00
	Draw Labels



## 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

# RTH C4 **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

## Roadway Designer - RT\_L-LAD\_097+40-99+25(2)

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_(	97+40-99+25	5(2)			
Type: Alignment					
Horizontal Alignme	ent: I				
Vertical Alignment					
_	_				
Start Station: 97+4					
Stop Station: 99+2	5.00				
Manage Corridors					
Name: RT_L-LAD_097	7+40-99+25(2) 🍘		Limits		Add
Surface Symbology:	1	-	Station	6	Close
Type:	Alignment	0-	Start	<u> </u>	Close
Horizontal Alignment:			97+40.00	+	Change
		* *	Stop:		Сору
Vertical Alignment	EX_L	<u>4) -</u>	99+25.00	+	Copy From
PI Rounding Tangent	0.0000				Copy riom
Corridors:					Help
Name	Туре	Source N	lame	Start Station	Stop Stati
LT_L-HAT_097+83	Alignment	LT_L-HAT	r_097+83	0+00.00	0+15.00
LT_L-HAT_108+00	Alignment	LT_L-HAT	F_108+00	0+00.00	1+67.96
LT_L-LAD_096+40-97+.	Alignment	L		96+40.00	97+80.00
LT_L-LAD_097+85-102.	. Alignment	L		97+85.00	102+00.00
RT_L-LAD_097+40-99+	Alignment	L I		97+40.00	99+25.00
3		III			The second se
					Delete
					2

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

Point Controls	
Corridor: RT_L-LAD_097+40-99+25(2)	Add
Control Description:	Close
Point: RT_DD_Base In_P-C1 -	Station Limits Start: 97+40.00 + Change
Mode	
O Horizontal O Both	Stop: 98+05.00 + Help
Control Type: Alignment	Horizontal Offsets
Horizontal Alignment	Start: 0.0000
Vertical Alignment	Stop: 0.0000
	Vertical Offsets
	Start: 0.0000 +
	Stop: 0.0000 +
Priority: 1	
Horizontal and Vertical Controls:	
Ena Prio Name Start Station Stop Stat	tion Mode Type Control De
X 1 RT_DD_Bas. 97+40.00 98+05.00	Ventical Alignment LDLRT2A
<	
OF TH	Delete

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.

Point Controls							
Corridor: RT_L-LAD	_097+40-99+25(2)						Add
Control Description: Point:		~#I	Station	n Limits		3	Close
Mode	RT_DD_Base In_P-	<u>c1 +</u>		98+10		<u>+</u>	Change
	🧿 Vertical 👘 Bo	oth	Stop:	99+25	.00	-	Help
Control Type:	Alignment	-	Horizo	ontal Of	fsets		
Horizontal Alignment	L		7.62.1622	0.000	120232	-4-	
Vertical Alignment:	DLRT3		Stop	0.000	5	*	
			Vertica	al Offse	ts		
			Start:	0.000	0	<u>+</u>	
Priority:			Stop:	0.000	0	+	
Horizontal and Vertical	Controls:						
En., Pri., Name		Start Stati	Stop	Stati	Mode	Туре	Control
	Base In_P-CTL-DDE		98+05	0.041.041	Vertical	Alignment	L:DLRT2/
V I ST SS	Base In_P-CTL-DDE	98+10.00	99+25	00	Vertical	Alignment	LDLRT3

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  $\rightarrow$  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.

Horizontal Cardinal Points	7.75
	r
Vertical Cardinal Points	Cancel
Horizontal Event Points	Preferences.
Vertical Event Points	Help

### 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.

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

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)



N.C. Dept. of Transportation | Incorporating Hydraulics Ditch Designs

### 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.

Job Number: RDY 🔻	Chain: L	Draw     DP Origin	Cross Section Labele	r 🚽	
XS Cells Surfaces		br_sangin			
Type Name		Display S	<b>₩</b>	Data File: HY-RT_1	
DTM C:\NCDOT Trai	in\RT_L-L <mark>AD_097+40-9</mark> 9	and the second se	General Slope	Label   Elev/Off La	bel   Sta Label   Text
				Job: rdy	•
				nain: L	<u> </u>
Details					
Dtm File: •	_097+40-99+25(2).dtm			ion: 97+50.00	
		Type: Line •	End Sta	tion: 99+00.00	<b>_</b>
Display Settings By Level Symbology		ilter Tolerances Horizontal: 0.3000		Denis	/ Labels
Feature: < No Entrie		Variance: 0.1000		Didw	Labers
Text Settings					
Elevation	12.34	Void			
47.63		3:1			

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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.

<u>File T</u> ools	\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Hydro_CMD\U4751_HYD.rdp
Job: hyd Q > Preferences DTM O Geometry Plan Graphics ALG Viewer	TIN/DTM Files         C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\U4751_ls_tin.dtm         C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Y8RPDB1-THY.dtm
	DTM: C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Y8RPDB1-THY.dtm Q

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.

Station Lock:	Even •
Slope Readout:	50% -
Horizontal Chord Height:	0.100000
Vertical Chord Height:	0.050000
Template Library:	C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\Hydro
DTM Files Path:	C:\NCDOT Training\Roadway\Hydro Ditches\CorridorModeling\

#### 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. <u>Remember to select and highlight</u> <u>only the Y8RPDB row only before importing the geometry</u>. 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

Eile Tools	NCDOT Trai	ning\Roadway\Hydro Ditches	\CorridorModeling\Hydro_C	MD\U4751_HYD.rdp		
ob: hyd Q >	+ <b>*</b> \$\$	\$\$				
- D Preferences	Chain	Profile	Drafting Standard			
	L	DLRT2A,DLRT3,DLRT4,	F Prop CL			6
- 🗖 Geometry 🕧	Y8RPDB	DY8RPDB_RT2,Y8RPDB	F_Prop CL 👩			Ę
Plan Graphics						
ALG Viewer						2
	Chain: Y	SRPDB 🕗 💌	.4°	Profile(s)		*
	Drafting St	andard: F Prop CL		DY8RPDB RT2		
	Draiting O	andara. Intropier		EX_L	0	
				W1_EX	~	H
				Y8RPDB		-
			Import 🕜	<u></u>		

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.

Vame: RT_Y8RPDB-ROD_62 Surface Symbology:		Station		Add
	0	Starl.		Close
Type: Align		62+00.0	00 +	Change
Horizontal Alignment: Y8RF	PDB 🕑	stop:		Сору
/ertical Alignment DY8F	RPDB_RT2	66+55	00. +	
PI Rounding Tangent 0.000	0			Copy From
				Help
Corridors:	1254			
Name	Туре	Source Name	Start Station	Stop Station
LT_L-HAT_097+83	Alignment	LT_L-HAT_097+83	0+00.00	0+15.00
LT_L-HAT_108+00	Alignment	LT_L-HAT_108+00	0+00.00	1+67.96
LT_L-LAD_096+40-97+80	Alignment	L	96+40.00	97+80.00
LT_L-LAD_097+85-102+00	Alignment	L	97+85.00	102+00.00
RT_L-LAD_097+40-99+25(2)	Alignment	È:	97+40.00	99+25.00
RT_L-LAD_100+30-109+00(3)	Alignment	L	100+30.00	109+00.00
RT_Y8RPDB-ROD_62+00-66+	55 Alignment	Y8RPDB	62+00.00	66+55.00
				Delete

### 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

na vez a vez	PDB-ROD_62+00-	00+00			U	Add
Control Description:					B	Close
Point:	RT_GS_OS_C	TL 🔐 +	Station	n Limits		0
Mode	- Leave and the second s		Start:	62+00.00		Change
Horizontal	Vertical	🖲 Both 🕗	Stop:	66+55.00	<b>⊙</b> <u>+</u>	Help
Control Type:	Feature	<b>3</b> .	Horizo	ontal Offsets		
urface:	Y8RPDB1-TH	r (4)-	Start	0.0000	+	
eature.	RT_GS_OS_C	TL 👩 +	Stop:	0.0000	+	
Use as Seconda	ry Alignment					
				al Offsets		
			Start	0.0000	<u>+</u>	
			Stop:	0.0000	+	
riority:	1					
lorizontal and Vertic	al Controls:					
En. Pri. Name	e Start Stati.	Stop Stati	Mode	Туре	Control	Description
K I RT_G	S_OS_62+00.00	66+55.00	Both	Feature	Y8RPDB1-	
	III					Ň

10. Save the IRD file.

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### 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  $\rightarrow$  Target Aliasing) to show the surface of the proposed Roadway. Add the following surfaces in this order to the Aliases list.

arget Aliasing		
Target <active surface=""></active>		60
Surface or Corridor	Aliases:	Can
Corridor - LT_L-HAT_097+83 Corridor - LT_L-HAT_108+00 Corridor - LT_L-LAD_096+40-97+80 Corridor - LT_L-LAD_097+85-102+00 Corridor - RT_L-LAD_097+40-99+25(2) Corridor - RT_L-LAD_100+30-109+00(3) Surface - Default Surface - U4751_Is_tn	Add -> 2 4 <- Remove Move Up Move Down	He
Surface - Y8RPDB1-THY 3	Use Closest	
arget Aliasing Target: <a href="https://www.example.com"><a a="" href="https://www.example.com" www.example.com"="" www.example.com<=""></a></a>		0
Target: <active surface="">   Surface or Corridor</active>	Aliases:	O Car
Target <active surface=""></active>	Aliases: Add -> Surface - U4751_Is_tm Surface - Y8RPDB1-THY Move Up Move Down	



### **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.



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

#### 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)

Vame:			Apply
Default Preference:	Default	•	G Close
Create Surface(s) from	n:		Preferences.
LT_L-HAT_097+83 LT_L-HAT_108+00 LT_L-LAD_096+40-9 LT_L-LAD_097+85-1	02+00		Help
RT_L-LAD_097+40-9 RT_L-LAD_100+30-1	09+00(3)		
RT_Y8RPD5-ROD_	62+00-66+55	None	
C	lipping Options		
General Options			
Vew Surface for	Each Corridor 🧖	Create Alter	nate Surfaces
Empty Design S	urface 祸 👅	Process Vis	ible Range Only
Empty Design S			
Include Null Poir		Process Vis	
Include Null Poir			
Include Null Poir			
Include Null Poir Triangulate Features Duplicate Names:		Remove Lo	
Include Null Poir Triangulate Features Duplicate Names:	its	Remove Lo	ops
Include Null Poir Triangulate Features Duplicate Names: ( Append	tts () Replace Features	Remove Lo	ops
Include Null Poir Triangulate Features Duplicate Names: (@ Append Add Transverse Style:	tts Replace Features Bridge Metal F	Remove Lo	ops
<ul> <li>Include Null Poir</li> <li>Triangulate</li> <li>Features</li> <li>Duplicate Names:</li> <li>@ Append</li> <li>Add Transverse</li> <li>Style:</li> <li>Add Exterior Boo</li> </ul>	its Replace Features Bridge Metal F undary	Remove Lo	ops
<ul> <li>Include Null Poir</li> <li>Triangulate</li> <li>Features</li> <li>Duplicate Names:</li> <li>Append</li> <li>Add Transverse</li> <li>Style:</li> </ul>	tts Replace Features Bridge Metal F	Remove Lo	ops
<ul> <li>Include Null Poir</li> <li>Triangulate</li> <li>Features</li> <li>Duplicate Names:</li> <li>@ Append</li> <li>Add Transverse</li> <li>Style:</li> <li>Add Exterior Boo</li> </ul>	tts Peplace Features Bridge Metal F undary Bridge Metal F	Remove Lo	ops
<ul> <li>Include Null Poir</li> <li>Triangulate</li> <li>Features</li> <li>Duplicate Names:</li> <li>Add Transverse</li> <li>Style:</li> <li>Add Exterior Boo</li> <li>Style:</li> </ul>	its Replace Features Bridge Metal F undary Bridge Metal F	Remove Lo	ops

### 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.

NEW CUT SLOPE STAKE LINE

ORIGINAL CUT SLOPE STAKE LINE .

### 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.

N	XS Cells Surfaces
5	Type     Name     Display Setti       DTM     Y8RPDB1-THY.dtm     Lv: Scratch_       DTM     C:\NCDOT Tra\RT_Y8RPDB-ROD_62+00-66+5! Lv: Exist XS     Ly:       DTM     U4751_ls_tin.dtm     Lv: Exist XS
	Details       Dtm File:     U4751_ls_tin.dtm     Q       Method:     Triangles     Type:       Display Settings     Filter Tolerances       By Level Symbology     Horizontal:     0.3000       Feature:     No Entries >     Variance:     0.1000       Text Settings     I2_34     Void
	<u>6:1</u> 5.99·1
-	6:1 38.95 <sup>1610</sup> 4.34:1 37.41