4. Culverts

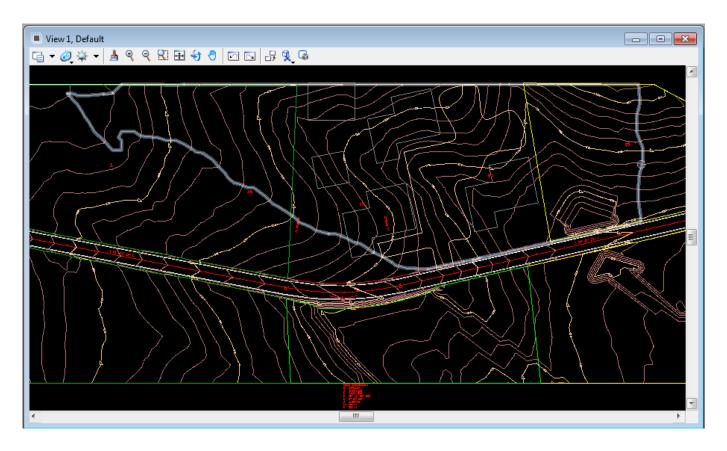
This exercise shows the user how to use the culvert module to design a culvert. The culvert module acts as a standalone component of GEOPAK Drainage, meaning it does not directly interact with Drainage Areas, Nodes, Links or Networks.

4.1 Delineate the Drainage Area

a) Use DTM tool Delineate Watershed to create the drainage area shown below. If necessary, refer back to exercise 3.2 to create the drainage area.

The following shape will be used below as the drainage area for this exercise.

NOTE: The area shown below on level SURVEY - DRAINAGE - Area Shapes extends to the limits of the current TIN file. Inspection of the contours will reveal that the drainage area most likely extends beyond these limits. **Appendix B** will discuss options to approximate the full extent of the drainage area.

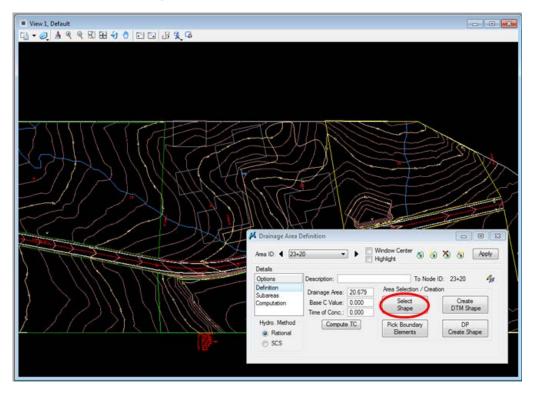


- 23 K DRAINAGE - DrainageProject.gdf - [No Active Network] Drainag... 🗵 Project Component Network Reports Utilities Tool Boxes 📰 🎬 Area F Add. 0 1 Node . Edit Drainage Areas: Add Drainage Area Link ۲ ID ø. Delete Profile . 風俗 Rename Culvert ۲ ¥, 4 Update All Routing H, 🎇 Land Uses <u>ا</u> **Miscellaneous Utilities** ۲
- b) From the GEOPAK Drainage menu bar select Component>Area>Add.

Type in 23+20 for the Area ID. Click OK.

Area ID:	23+20
Description:	

c) Click the Select Shape button. Select and data point to accept the shape shown in the first step. The area is automatically calculated.



📕 Drainage Area D	efinition		
Area ID: 4 23+2		Window Center Highlight	🖄 🖓 🗛 Apply
Details			
Options	Description:	To Node I	D: 23+20 🏼 💋
Definition Subareas Computation	Drainage Area: 20.679 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Creation	on Create DTM Shape
Hydro. Method	Compute TC	Pick Boundary Elements	DP Create Shape

d) Set the Base C Value to 0.350 and click on Compute TC

When the following Dialog will appears, use the explorer button to select the correct TIN file.

📕 Time of Concentration 🛛 🗖 💌 💌
Drainage Area ID: 23+20
TIN File ▼ final.tin Q
Define Path Trace () ID - Segments
Method: FHA Length: 0.000
n Value: 0.000 Slope: 0.000
Shallow Flow
Length: 0.000
Inter. K: 0.000 Slope: 0.000
Concentrated Flow
Method: Continuity Length: 0.000
Velocity: 0.000
Accum. Distance: 0.000 Accum. Avg. Slope: 0.000
Tc= 0.000 Compute Apply

e) Expand window to show details and set Max Sheet Flow Distance to 300' and Max Shallow Flow Distance to 100'.

📕 Time of Concentration		x
	Details	
Drainage Area ID: 23+20	Distance Slope Avg. Slope Flow	
TIN File Final tin Q		_
Define Path		2
Trace [] ID - Segments		Ð
Sheet Flow		×
Method: FHA Length: 0.000		0
n Value: 0.400 Slope: 0.000		
Shallow Row		
Length: 0.000		
Inter. K: 0.457 Slope: 0.000		
Concentrated How	Distance: Slope:	
Method: Continuity Length: 0.000	Distance: Slope: 0.000 0.000 Adjust Flow	
Velocity: 5,000	0.000	
	Max Sheet Flow Distance: 300.000	
Accum. Distance: 0.000	Max Shallow Flow Distance: 100.000	
Accum. Avg. Slope: 0.000		
Tc= 0.000 Compute Apply	Apply	

Collapse the window, toggle ON Sheet Flow, Shallow Flow and Concentrated Flow and fill in the values as follows:

n Value: 0.400 Inter. K: 0.457

Velocity: 5.000

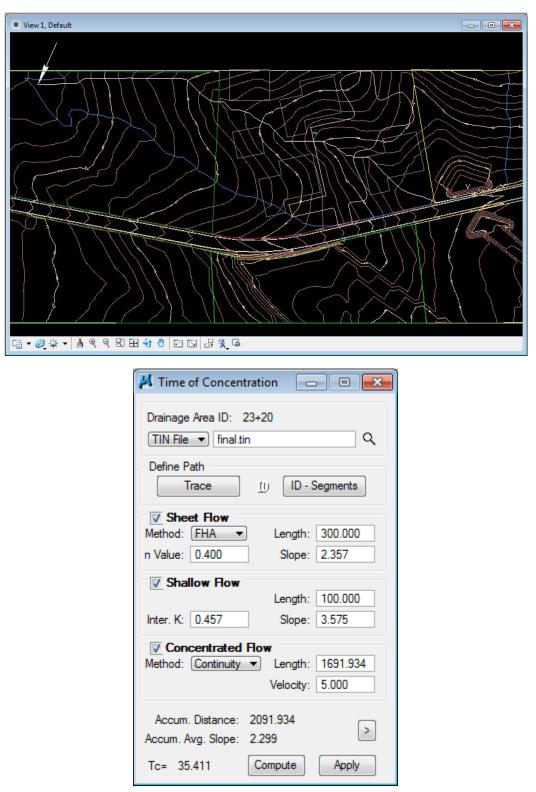
n Values for different surface types are available in the <u>TDOT Drainage Manual</u>, Table 4-3 *Manning's n Values for Overland Flow*

Intercept K values are below:

Land Cover / Flow Regime	k
Grassed waterway (shallow concentrated flow)	0.457
Unpaved (shallow concentrated flow)	0.491
Paved area (shallow concentrated flow); small upland gullies	0.619

NOTE: See Appendix D for additional Manning's N and Intercept K Values.

f) Click **Trace** and data point at the furthest hydraulic point. Once values are calculated, click **Compute**. Then click **Apply**.



The Drainage Area Definition is now filled out.

Drainage Area D Area ID: 4 23+2	0 🗸 🖌 🕅 Wi	indow Center ghlight 🖄 🔞	
Details			
Options	Description:	To Node	ID: 23+20 🦓
Definition Subareas Computation	Drainage Area: 20.679 Base C Value: 0.350 Time of Conc.: 35.411	Area Selection / Creat Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

NOTES:

Minimum Time of Concentration is 5 minutes. If computed time is less than **5 minutes** input 5 manually.

For urban areas adjust maximum sheet flow as required.

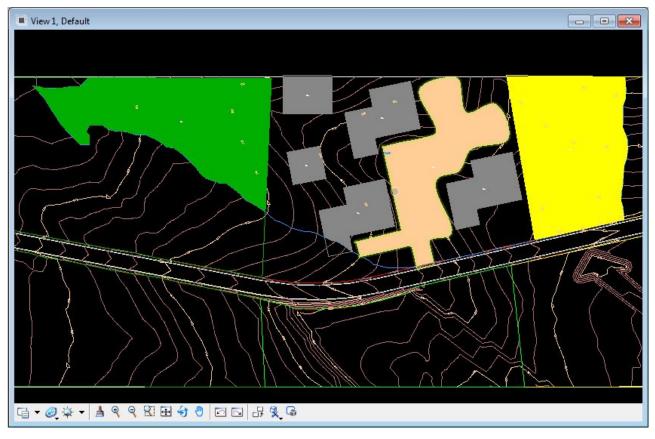
For areas that drain directly from sheet flow to concentrated flow, uncheck the Shallow Flow box. Leaving this box checked and setting it to zero will not allow TC to be calculated correctly.

After the drainage area has been set up, runoff coefficients can be automatically computed with the use of *Land Use Items* from the Drainage Library. Click on **Subareas** in the Details list on the left.

Area ID: 4 23+20	Highligh	r Center 🐴 🔞 🕅	Apply
Details			
Options		To Node ID:	23+20 💋
Definition	Subarea C Value Descri	ption	
Subareas			Automatic
Computation		E	Delineation
111111111		-	Display Only
Hydro. Method		1000	
Rational		×	<
 National 			

g) Toggle ON **Display Only** and then click the **Automatic Delineation** button. The file is scanned for closed shapes matching the Land Use symbology specified in the Drainage Library (Land Use Tab).

🗸 Drainage Area S	ubareas				
Area ID: 4 23+2	0	• •] Window Center] Highlight	a Xa	Apply
Details	_				
Options			To Node	e ID: 2	23+20 🖉
Definition	Subarea	C Value	Description		
Subareas	3.3941	0.900	Conc/Asphalt Pvmt		Automatic
Computation	2.8738	0.600	Gravel	1	Delineation
	4.4692	0.300	Forested Areas		Display Only
Hydro. Method	4.3610	0.400	Cultivated Fields		
Rational				$ \times $	
<u> </u>					
SCS	4.361	0.400	Cultivated Fields	1	
	4.001	0.400	Cultivated Helds		



h) Click the **Apply** button to apply the land uses (and their "C" values) to the Drainage Area.

 We want to compute the discharge for a 50-year storm so if that is not already set; select Project>Preferences>Frequency Options and change the Frequency to the 50-year storm. Click the OK button to accept the new preference setting.

e
itions its iject Components infall Parameters and Use Options equency Options ensity Option action Losses et Options de Options k Options file Options in Symbology dates ve Options OK Cancel

j) Return to the Drainage Area Computations>Computation dialog box and click the Compute Discharge button:

📕 Drainage Area Co	omputations					
Area ID: 4 23+20	•	Window Center	종 🙆	8	8	Apply
Details						
Options		Area	C Value	ſ	Con	mpute
Definition Subareas	Total Subareas:	15.098	0.521			charge
Computation	Remainder:	5.581	0.350			
Hydro. Method -	Composite:	20.679	0.475			
Rational	Computed Intensity:	3.993				
SCS	Computed Discharge:	39.200				

Verify the Computations; then click **Apply** to add the Area to the Project.

- **k)** Jot down the Computed Discharge from the 50-year storm computed in the step above here: _____
- Recompute the drainage area discharge for the 100 Year storm. Select Project>Preferences>Frequency Options and change the Frequency to the 100 year storm. Click the OK button to accept the new preference setting.

<u>F</u> ile		
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Link Options Profile Options Plan Symbology Updates Save Options OK Cancel	Drainage Library (DLB):\Geopak Standards\TDOTEnglish.dlb Rational Frequency Options Computation Runoff Coefficient Frequency: Peaking Factor: 100 Year 1.0000 SCS Frequency Options Cumulative Runoff Coefficient Frequency: Peaking Factor: 1.0000	

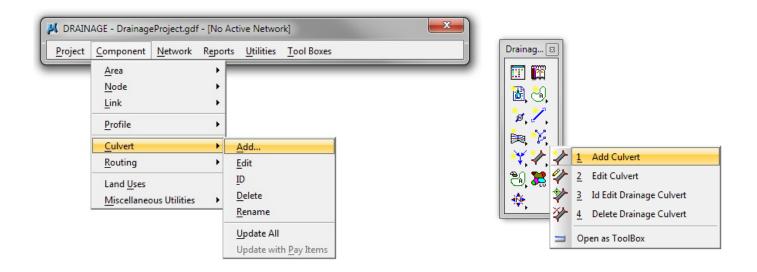
m) Return to the Drainage Area Definition dialog box and click the **Compute Discharge** button:

📕 Drainage Area Co	omputations					
Area ID: 4 23+20	•	Window Center	ත ක	8	8	Apply
Details						
Options		Area	C Value	Γ	Cor	mpute
Definition Subareas	Total Subareas:	15.098	0.521			charge
Computation	Remainder:	5.581	0.350			
Hydro. Method -	Composite:	20.679	0.475			
Rational	Computed Intensity:	4.324				
	Computed Discharge:	42.449				

- n) Jot down the Computed Discharge from the 100-year storm computed in the step above here: _____
- o) Close the Drainage Area Definition dialog box.
- **p)** Change the Frequency back to the 50 Year storm

4.2 Design the Culvert

a) From the Drainage main menu, select Component > Culvert> Add.



b) Click on the Add button to add a new culvert. Enter the Culvert Name as 23+20 (station of the culvert) and Click OK.

Name:	23+20
Description:	

Culvert ID: 4 23+20 Description:	- ►	* *	Apply
Details			N
Culvert Profile		Overtopping	Computations
Parameters	C	onfiguration	Headwall Location
User Supplied Design Discharge 0.000	а Ф Х	User Supplied Tailwater Elevatio	

c) The Culvert dialog will open as seen below:

d) Enter the culvert discharges from Steps 11 and 14 in the previous exercise. Key-in the discharges in the key-in field and click the **Add List Item** button for each discharge

etails			
Culvert Profile	(Overtopping	Computations
Parameters	Co	onfiguration	Headwall Location
User Supplied Design Discharge 39.200 42.449		User Supplied Tailwater Elevation 0.000	

e) Highlight the 50-yr storm and click **Select Discharge**. This will be the Discharge that the culvert is designed for.

Description:	• •	* * *	
Details Culvert Profile		Overtopping	Computations
Parameters		Configuration	Headwall Location
Discharge User Supplied Design Discharge X 39.200 42.449 39.200	*□ ₽ ×	Tailwater User Supplied Tailwater Elevation 0.000	₩ ₽ ×

You could also just double **click** to set the desired Design Discharge that the culvert is designed for.

f) Define the tailwater. Set the **Tailwater** option to **Compute** and key-in the slope and N Value.

NOTES:

This slope is the longitudinal slope of the downstream channel. This slope can be determine utilizing the **Analysis** tool: **Height/Slope** located in **Applications>GEOPAK>ROAD>DTM Tools**

N Values for different surface channels are available in the <u>TDOT Drainage Manual</u>, Table 5A-1 Values of Roughness (See Appendix E).

ዞ Culvert		
Culvert ID: 4 23+20 Description:	• •	🐦 🤌 🎓 🖬 🖬 Apply
Details Culvert Profile Parameters		Overtopping Computations Configuration Headwall Location
Discharge User Supplied ▼ Design Discharge X 39.200 42.449 39.200	[™] ₽ ×	Tailwater Extract Cross Section Slope %: 0.800 N Value: 0.040 Adjust Tailwater Depth: 0.000 0.000

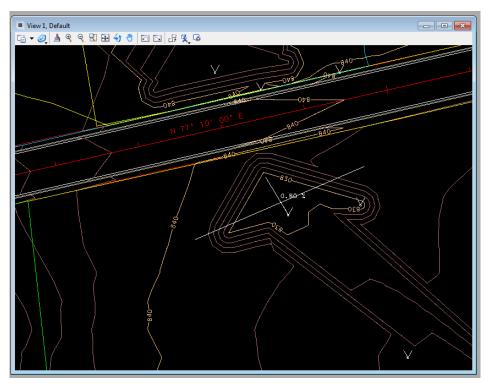
Set the Slope % to 0.800 and the N Value to 0.040 and click the Extract Cross Section button.

g) The Define Culvert Tailwater Cross Section dialog will open. Set to Drape Element on Model/TIN and TIN File.

ction Symbology	ОК	Cancel	
Drape Element on Model / TIN	TIN File Inal.tin		Q
Select Element Place Eleme	nt		Se
Extracted Profile			
Profile ID: 23+20	Description:		
	Horiz. Scale:	10.000	
	Vert. Scale:	1.000	R
	Max. Elevation:	662.169	e
	Min. Elevation:	650.689	s e
	Max. Station:	97.020	t
	Min. Station:	0.000	

Click on the Select Files button and select final.tin.

h) Click the Place Element button to locate the postion of the tailwater <u>cross section</u> that is to be extracted (this is notated as the 'Extracted Profile' on the dialog).:



i) The **Define Culvert Tailwater Cross Section** dialog will now contain the profile along the element placed representing the channel cross section at this location.

ection Symbology			ОК	Cancel	
Drape Element on	Model / TIN 💌	TIN File 🔹	final.tin		
Select Element	Place Element				
Extracted Profile					
Profile ID: 23+20		Description:			
			Horiz. Scale:	10.000	
1.22			Vert. Scale:	1.000	R
			Max. Elevation:	842.050	e
		/	Min. Elevation:	826.854	e s
	/		Max. Station:	331.690	t
	/		Min. Station:	0.000	
-				e Profile	-

j) Click the **OK** button and the main culvert dialog will open again. The values for the tailwater section will now be populated.

Uvert II Descri		3+20	• •	* *	* * 2 0	Apply
etails						
	Culve	rt Profile		Overtopping	Com	putations
	Param	neters		Configuration	Headwa	Il Location
0	ischarge User Supj Design X	Discharge 39.200 42.449	D	Slope %: 0.800 Adjust	N Value: Tailwater Depth:	
			×	Distance 0.000 7.689 13.092	Elevation 839.536 839.442 839.375	
		39.200		0.000	0.000	

- K Culvert X Culvert ID: - 1 23+20 * * * 5 Apply Description: Details **Culvert Profile** Overtopping Computations Parameters Configuration **Headwall Location** Entrance Type Shape: Circular Material: Concrete -Culvert Size Design Size • Headwater Elevation -836.500 Maximum Rise: 5.000 Minimum Rise: 1.500 Number of Barrels: 1 -Design Barrels Headwall bevel = 45[^] Roughness: 0.013 Select Entrance... Entrance Ke: 0.200
- k) Select the Configuration tab to define the type of Culvert. Make settings as listed below.

Shape: Circular

(Culvert Shape: Circle, Box, Ellipse, Etc.)

Material: Concrete

(Culvert Material: Concrete, Steel, Plastic, Etc.)

Headwater Elevation: 836.50

(The maximum elevation the water can reach at the upstream end of the culvert). By default this option is set to Allowable Headwater which uses a height value, click to change to Headwater Elevation.

Maximum Rise: 5.000

(The maximum diameter, height of the culvert)

Minimum Rise: 1.500

(The minimum diameter, height of the culvert)

Design Barrels: Toggle ON

(Allows the program to design multiple barrels, if required)

Number of Barrels: 1

Roughness: 0.013

(Determined by the type of Material, See the <u>TDOT Drainage Manual</u> Section 6.04.2.4.3, *Culvert Roughness Coefficients*)

NOTE: If you know the size of culvert you need beforehand you may set Culvert Size to 'Library Item' and pick from the list of defined items.

 Click Select Entrance and select the appropriate entrance condition. The most commonly used for TDOT projects is Headwall beveled 45[^]. Select this condition and click ok. This will automatically set the Entrance Ke value.

Select Entrance Type		
	6	
Headwall square edge	Projected	Mitered
Headwall beveled 45 [^] Headwall beveled 33.7 [^] OK		incel

m) Select the Headwall Location tab to define the location of the Upstream Headwall and Downstream Headwall (nodes). Make settings as listed below.

ulvert ID: <u>23+20</u> Description:	•	* *		Apply
etails	70			
Culvert Profile	Ove	ertopping	Computati	ons
Parameters	Conf	iguration	Headwall Loc	ation
Upstream Headwall Reference Chain: CL Node ID: 23+20- Library Item: Culvert				•
Tangent to Ref. Chain	• #	Tangent to Ref.	Chain 🔹 💉	
Chain Sta.:	Mirror Cell	Chain Sta.:	M	irror Cell
Offset: 0.000	+ Angle: 0.000	Offset: 0.00	0 + Angle:	180.000
Invert Elev.: TIN / Mode	• 0.000	Invert Elev.: TIN	1/Model ▼ 0.0	000
		-	ce Keyin F	

Type: Plan View

Reference Chain: <u>CL</u> (Roadway Centerline)

TIN File: final.tin

Library Item: Culvert Endwall

Alignment: Tangent to Ref. Chain

+ Angle.: <u>0 or 180</u>

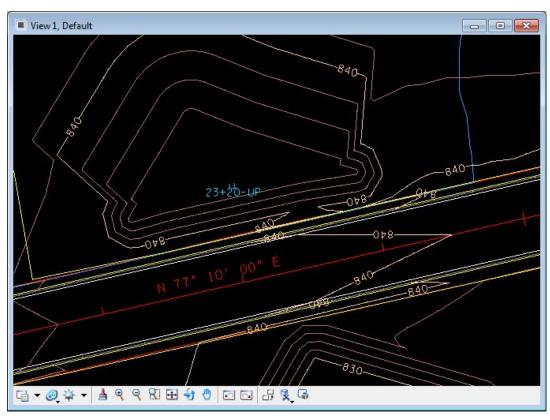
(For headwalls parallel to the roadway on the right side use an angle adjustment of 180 and on the left use 0. In this case the upstream is on left so that value should be set to 0.)

NOTE: Another option is to use Mirror Cell. Set angles to 0 and Toggle ON for headwalls on the right of the roadway and Toggle Off for headwalls on the left of the roadway. Do <u>NOT</u> use Mirror Cell along with Angle Rotations as this adds confusion.

Invert Elev.: TIN / Model

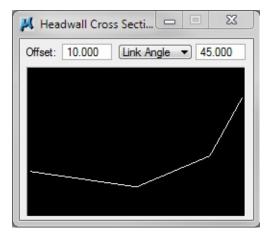
(Reads TIN elevations. Use 'User Supplied' inverts are known or are different than TIN file.)

n) Locate the Upstream Headwall by clicking the Dynamic Place button and setting the upstream headwall at a location similar to that shown below:



Watch the **Headwall Cross Section** dialog box appear upon mouse-movement. Use this viewer to place the Headwall at the upstream **low point**.

Station and offset values for the headwall location should change dynamically in the dialog as you move your mouse. If not, reset the chain name and try **Dynamic Place** again. It may be necessary to close the tool and reopen.

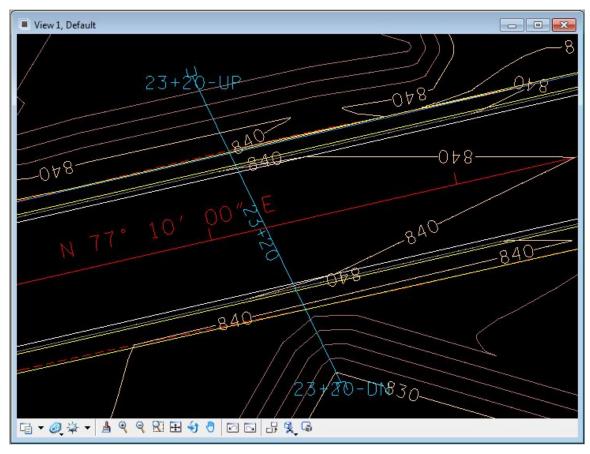


NOTES:

To set the headwall locations for 90 degree cross drains, you can enter the centerline crossing station with a given offset and click the Keyin Place button.

You may wish to utilize the **DTM Tools>Low Point Tool** as discussed in the DTM Tools Section 3 in order to predetermine the low point locations.

o) Locate the downstream headwall by clicking **Dynamic Place** under the **Downstream Headwall** group.



Ilvert ID:	• •	*	× × :	Apply
etails				
Culvert Profile	Ove	rtopping		Computations
Parameters	Config	guration	H	eadwall Location
Upstream Headwall Reference Chain: CL Node ID: 23+20-UP Library Item: Culvert Endwal				
Chain Sta.: 23+07.99	# Mirror Cell ngle: 0.000 832.847	Tangent to I Chain Sta.: 2 Offset: 6 Invert Elev.:	23+36.61 63.525	
	eyin Place	Dynamic		Keyin Place

p) Select the **Overtopping** tab to define the limits of roadway overtopping. Make settings as listed below and click **Extract PGL Profile**.

NOTE: This step is only necessary if your culvert is in a **sag** condition. If you are not in a sag condition you may proceed to **Step 17.**

Culvert ID: 4 2 Description:	3+20 🔹]		* *	* 2 0	Apply
Details					
Para	meters	Config	guration	Headwall Locati	ion
Culvert	Profile	Overto	pping	Computations	
Width: 48	.000 V Paven Extract PGL Profile		Distance	Elevation	
Reference Chain:	CL -	1			면
	DESIGNCL -				×
Begin Station:	22+00.00	DP			
End Station:	25+00.00	DP	0.000	0.000	
X Increment:	5.000		0.000	0.000	

Overtopping Source: PGL

(This option sets the roadway profile as the controlling surface elevation for overtopping. Other options include 'User Supplied' or constant elevation and 'DTM')

Width: <u>48.00</u>

(This is the width of your roadway)

Pavement: Toggle ON

(This should be checked unless your road is not paved)

Reference Chain: CL

(Roadway Centerline)

Ref. PGL: DESIGNCL

(Roadway Profile)

Begin Station: <u>22+00.00</u>

(Use the **DP** button to select a point before the Culvert.)

End Station: 25+00.00

(Use the **DP** button to select a point after the Culvert.)

X Increment: 5.000

(This may be automatically adjusted depending on the distance between the begin station and end station.)

- **q)** Once the Nodes have been located, and the elevations appropriately calculated, the Culvert can be added to the project. Click the **Apply** button and the culvert will be drawn and labeled according to the symbology in the Preferences.
- r) The information to this point is enough to check the culvert computations. Select the Computations tab. Toggle on the option to view the Culvert calculations. Click the Compute Culvert button to perform the calculations.

Culvert		
Culvert ID: 23+20 Description:	⊻ ► * *	🔸 💝 🗹 🛛 Apply
Details		
Parameters	Configuration	Headwall Location
Culvert Profile	Overtopping	Computations
Culvert Design Results for Circular Concrete Suggested Design 36 Inch Dia. Circular Rise = 3.000 Output Compute Culvert Culvert Overtopping	r 23+20 ✓ Output to ASCII: 23+20.out	Create View

NOTE: You may include Tailwater and Overtopping calculations (if you need them) by toggling ON the option to view them.

To view the Culvert Design Results, simply press the "View" button on the lower right of the "Culvert" menu to access the output file or you could open the file "23+20.out" from your Project Folder. View and/or print the Culvert Design Results that the Geopak Drainage software has calculated for you. Alternate design options have been found that may be considered.

The report also includes hydraulic computations such as Maximum Head Water Depth and Outlet Velocity for Q50 and Q100 which are helpful in analyzing the culvert design.

Culvert	Allow.	MAX	Inlet	Outlet	Tailwater
Discharge	HW	HW	HW	HW	Elev.
39.200	836.500	835.926	835.926	835.926	829.770
44.429	836.500	836.240	836.240	836.240	829.800

For the 50 year storm, the Head Water Depth is 835.926 ft. Using the DTM Height/Slope tool, a shape may be drawn at that elevation which represents the water surface for this storm event. This is the white shape in the picture below.



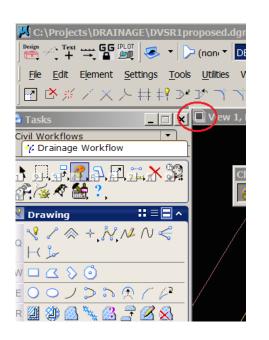
The Microstation Change Element Fill Type tool can be used to illustrate the ponded water for visual analysis. Use the Change Attributes tool to change the color to blue if desired.

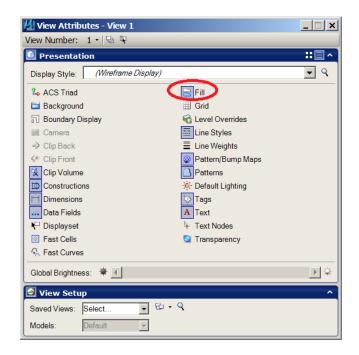
Change Attributes - MainX	🐐 Change Element Fill	_ 🗆 🗙
💽 💳 🔁 🏁 🛷 e ^g e ^g	Fill Type: Opaque 🔻	
Change Element Fill Type	Fill Color: Element	

Exercise 4

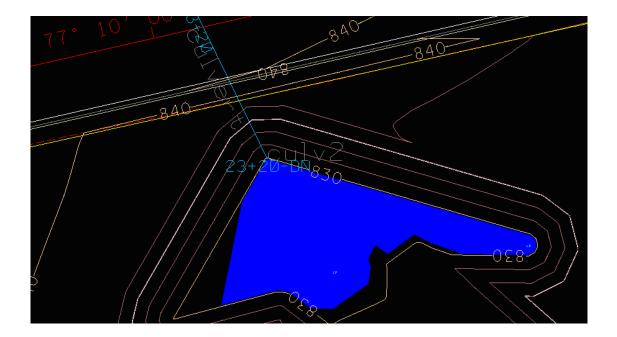
🐐 Change Attribu	tes 📃 🗆 🗙		DTM
Use Active Attrib	outes		
Level:	DESIGN - SCRATC		840
Color:	69 🔽		
Style:	3 🔻		
Weight:		040	
Transparency:	0 🗸	° / / /	
Priority:	₽ 0 -		
Class:	Primary 🔻		1v1
Template:	None	23+20-1	048
Use <u>F</u> ence:	Inside 🔻		840078
Make Copy		048	
Change Entire E	Element	77. 10' 00	a40

Be sure that your Fill is toggled On in the View Attributes menu.





Similarly, a visualization of the Tail Water pond may be created.



The Drainage Manual states that outlet velocities on Culverts should be based on the 50 year storm. In our file 23+20.out, we see that Geopak Drainage has calculated the Outlet Velocity for the 50 year storm at 13.567 fps.

39.20013.5671.2842.0380.0050.02444.42914.0241.3782.1720.0060.024	Culvert Discharge					
	39.200 44.429	13.567 14.024	1.284 1.378	2.038 2.172	0.005 0.006	

The use of riprap as scour protection at a culvert outlet is discussed in Section 6.04.3.3 of the Drainage Manual. It says that riprap can be used to provide protection at a culvert outfall for velocities between 5 fps and 12 fps. Since our velocity is greater than 12 fps, we would either need to lessen the slope of the culvert, thereby reducing the velocity at the outlet, or we would need to design a stilling basin or some other type of energy dissipator. See the Drainage Manual for guidance.

Before the next step, go back to "Configurations", **change Culvert Size to "Library** Item" - 36 Inch Dia Circular. Then, select the Culvert Size drop down and switch it to Design Size and set the Maximum Rise to 3.

ulvert ID: 4 23+20 Description:	<u>▼</u>	Apply
etails		
Culvert Profile	Overtopping	Computations
Parameters	Configuration	Headwall Location
	Material: <u>Concrete</u> Culver Size Library Item 36 Inch Dia	. Circular
an terfantanan del ar		

4.3 Culvert Profile

At this point, the designer has the pipe size that will be required and can use regular Geopak proposed cross section tools to set up a culvert section to finalize the length & inverts for the cross drain.

The next several steps illustrate the functionality available through Geopak Drainage to set up a culvert section in profile format along the cross drain.

a) On the Headwall Location tab click on Create Profile to set up a culvert section and finalize headwall locations. The Create Plan View Culvert Profile dialog will open up. Make settings as shown below.

Set Horiz scale 10 and Vert scale 10.

Change max and min elevations to be the next even 10' up or down.

Use default values for Max and Min station.

ection Symbology	ОК	Cancel
Drape Element on Model / TIN	final.tin	
Select Element Place Element		
Extracted Profile		
Profile ID: 23+20 Description:		
	Horiz. Scale:	10.000
	Vert. Scale:	10.000 F
	Max. Elevation:	850.000 e
	Min. Elevation:	820.000 s
	Max. Station:	152.986 t
	Min. Station:	0.000
	Place	e Profile

b) Click on the Symbology tab and make the following settings:

ection Symbology	
Ground Line Symbology	Boundary Symbology
Vertical Grid	Horizontal Grid
Major Interval: 10.000	Major Interval: 10.000
Minor Interval: 2.500	Minor Interval: 0.250
Major Symb.:	Major Symb.:
Minor Symb.:	Minor Symb.:
Major Text.:	Major Text.:

Ground Line Symbology (Proposed Roadway):

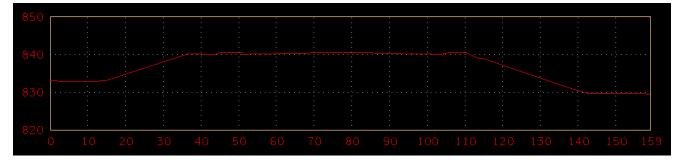
LV= DESIGN - TYPICAL - Finished Grade and Subgrade CO= 6, Style=0, WT=4

Boundary Symbology:

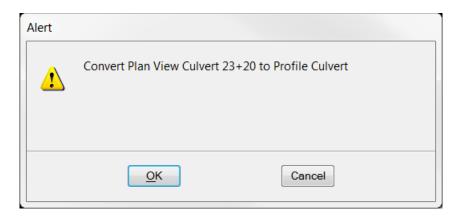
LV= DESIGN – SHEET – Light Grid CO=2, Style=0, WT=4

```
Vertical Grid Major Interval:
                        ON, Value=10
Vertical Grid Minor Interval:
                        OFF
Vertical Grid Major Symbology:
                        LV= DESIGN – SHEET – Light Grid
                        CO=0, Style=1, WT=1
Vertical Major Text:
                        LV= DESIGN – SHEET – Corner Text
                        CO=6, WT=10, TH=2, TW=2, FT=LEROYMON(3)
                        Click the Top Center to set Justification
Horizontal Grid Major Interval:
                        ON, Value=10
Horizontal Grid Minor interval:
                        OFF
Horizontal Grid major symbology:
                        LV= DESIGN – SHEET – Light Grid
                        CO=0 Style=1 WT=1
Horizontal Major Text:
                        LV= DESIGN – SHEET – Corner Text
                        CO=6, WT=10, TH=2, TW=2, FT=LEROYMON(3)
                        Click the Middle Right to set Justification
```

c) Once symbologies are set click on the Section tab and click on Place Profile in the lower right of the dialog. Culvert Section graphics will appear on the cursor, Data Point out in the open somewhere to place the graphics. Click OK on Create Plan View Culvert Profile dialog to dismiss and reopen the Culvert Edit dialog. Click Apply to store the culvert information.



d) Now that we have placed our culvert section we can finalize our inlet and outlet locations. On the Headwall Location tab change Type from Plan View setting to Profile View. When prompted to "Convert Plan View Culvert to Profile Culvert" click OK:



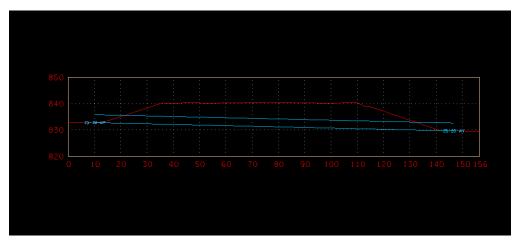
e) The Headwall location tab will change to show Profile view controls.

ulvert ID:		Apply
etails		
Culvert Profile	Overtopping	Computations
Parameters	Configuration	Headwall Location
Upstream Headwall Reference Chain: CL Node ID: 23+20-UP Library Item: Culvert Endwall Drape Angle: 295.2613 + Ar Invert Sta.: 12.190 Invert Elev.: 832.901 Chain Sta.: 23+08.46	ngle: 257.572 Drape Angle Invert Sta. Invert Elev Chain	Chain: CL ▼ ID: 23+20-DN m: Culvert Endwall ▼ a: 295.2613 + Angle: 77.572 .: 145.643 ↔

f) Under Upstream Headwall controls click Station DP button. Move cursor over culvert section profile near the upstream end of pipe. That end will start dynamically tracking with cursor movement. Relocate inlet so that the upstream invert of the pipe coincides with roadway side slope.

NOTE: This location could be located previously with Microstation commands or calculated and input as values in the Invert Sta. & Invert Elev. Keyin fields.

g) Repeat this procedure on the **Downstream Headwall** by clicking on **Station DP** and locating in culvert section profile.



h) Once Headwall locations have been reset click on Apply in the upper right corner of the Culvert Edit dialog. Now go back to the Computation tab and this time before clicking on Compute Culvert, toggle ON option for Output to ASCII, keyin name 23+20.txt and set file to Create option.

When **Compute Culvert** is clicked the output data in dialog is updated and text output file is created.

Uvert ID: 4 23+20 Description:	• • •	🔶 🌾 🛃 🖬 🛛 Apply
etails		
Parameters	Configuration	Headwall Location
Culvert Profile	Overtopping	Computations
Culvert Design Results	for 23+20	E
Circular Concrete 36 Inch Dia. Circular Rise = 3.000 Number Of Barrels = 1 Length = 110.555 Slope = 0.022 Output		
Circular Concrete 36 Inch Dia. Circular Rise = 3.000 Number Of Barrels = 1 Length = 110.555	for 23+20 ✓ Output to ASCII: 23+20.bt	Create View

i) To place drainage info with culvert section profile :

Set active text settings by going to TDOT>Cross Sections>XS Text Styles Plus, set Scale to 10 and select XS Drainage - Prop.:

Click to set Text s Level, Weight & Co	
XS Bridge Limits - Pro	р. 🔺
XS Drainage - Exist. XS Drainage - Prop.	
XS Finished Grade - I XS Finished Grade SI XS Pavement - Exist XS Retaining Wall - F XS ROW - Exist. XS ROW - Prop. Scratch XS Subgrade Slopes	opes - Prop. Irop.
Set Alternate STD	Place Label with Leader Line
Text Size	

Go to Microstation's **File>Import>Text** and pick the file **23+20.txt** in your project directory. Data Point in the DGN file for placement near the culvert section profile. This data can now be used when filling out TDOT Standard Drainage Data cells or can be edited to show additional data needed with the culvert section.

