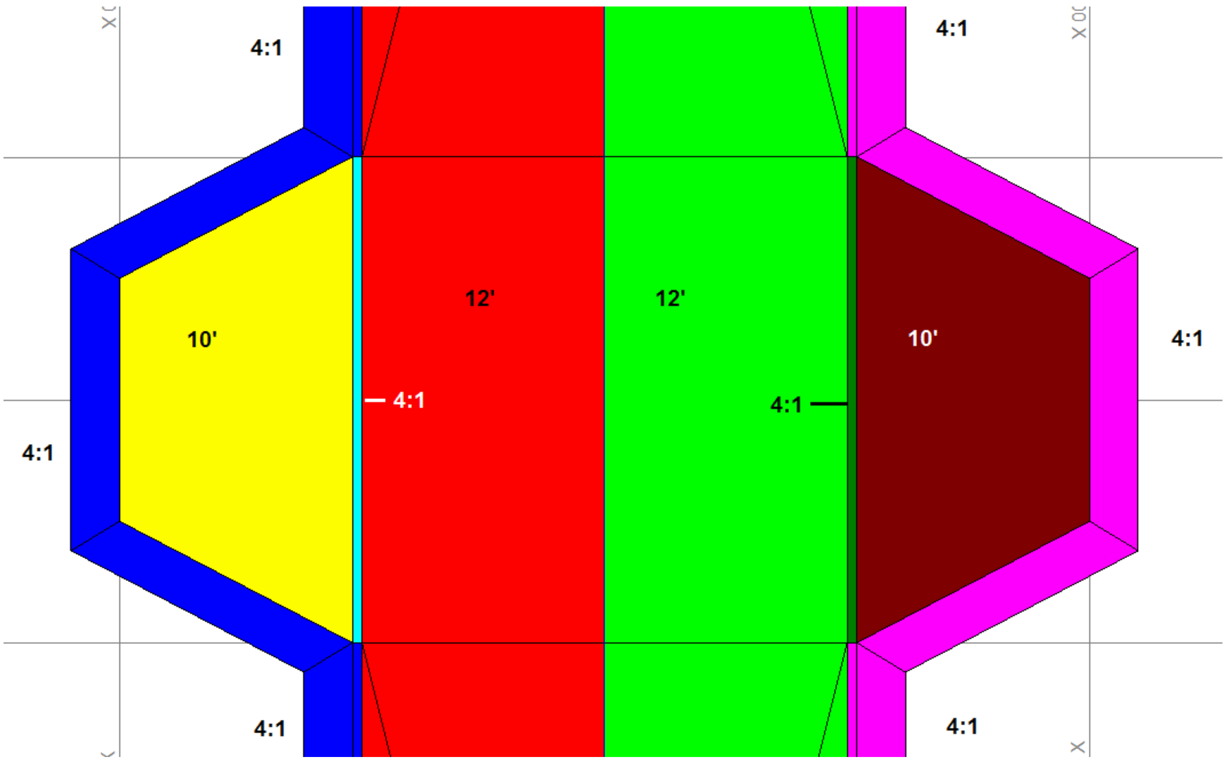
Turning Basins

By Pat Sanders

I recently spent a couple of days testing the CHANNEL DESIGN, ADVANCED CHANNEL DESIGN (ACD), CROSS SECTIONS AND VOLUMES (CSV) and TIN MODEL programs to see how they handled the volume computation for turning basins.

FIGURE 1. Sample Channel with Two Turning Basins

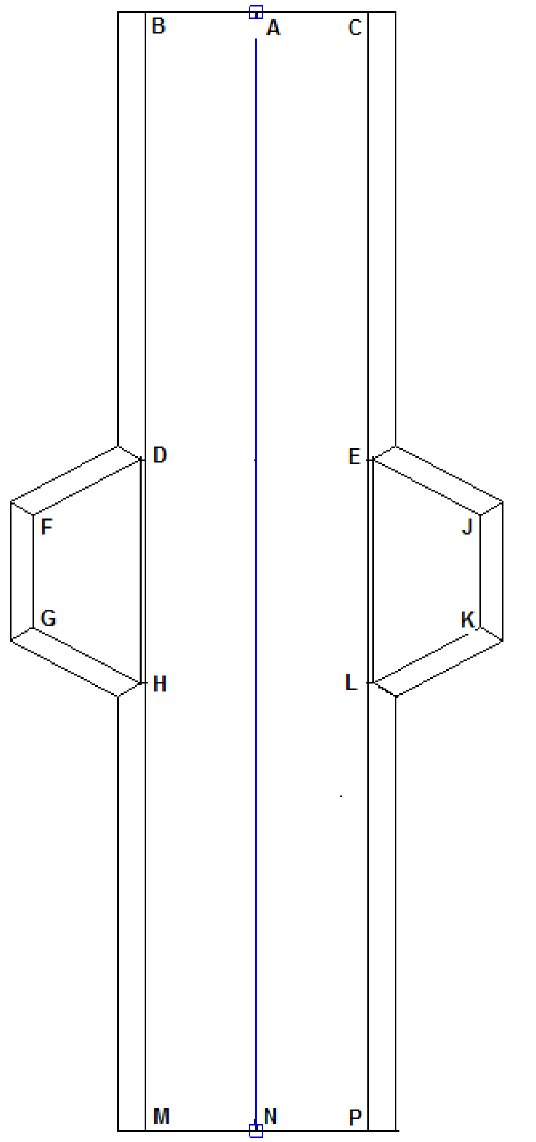


We define a “Turning Basin” as an area off to the side of a channel that is at a different depth than the main channel. In Figure 1, the main channel is at 12’ and we have two turning basins at 10’ on both the left and right hand sides. There is a zone between the main channel and the turning basin where a side slope is used to transition from the main channel to the turning basin. It’s the light blue area on the left and the dark green area on the right.

Both the CHANNEL DESIGN and ADVANCED CHANNEL DESIGN programs have tools to allow you to create a turning basin or multiple turning basins when laying out your channel. We’ll take a look at both methods.

MAKING A TURNING BASIN IN CHANNEL DESIGN

FIGURE 2. Sample Channel in CHANNEL DESIGN



We're going to enter the X-Y values for Points N and A as the **Centerline points**.

We'll enter points M, H, D and B as the **Left Toe Points**. We need the H and D points in the Left Toe list as the "anchors" for the turning basin have to be in the toe list. We'll use the same points in our Left Basin list.

For the **Left Basin**, we'll enter the points H, G, F and D. The primary rule for creating a turning basin is that it has to start and end on a point that is also in the toe listing.

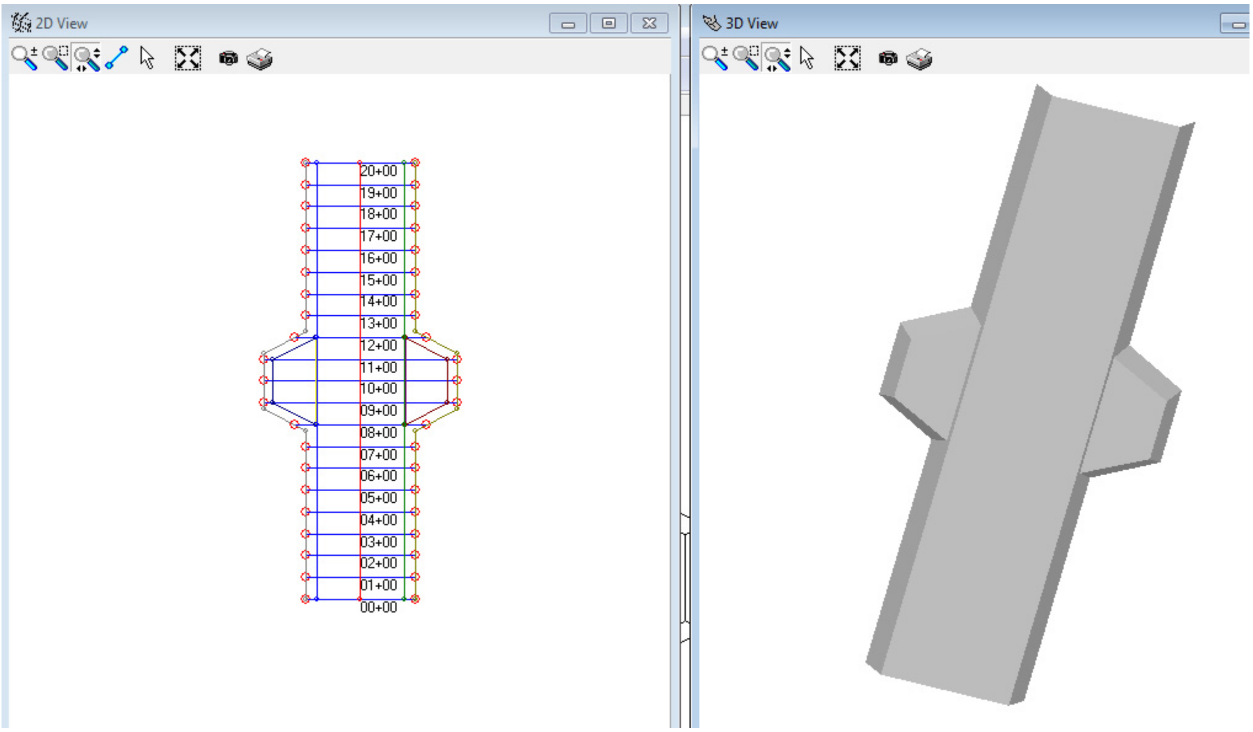
Based on the side slope transition value, it will compute a point uphill from point H and D that is at the specified depth of the turning basin. It will then complete the geometry of the basin.

In CHANNEL DESIGN, the resulting geometry around the turning basin will work out the best if the side slope ratio is the same for the left toe and the turning basin!

Also, you *cannot* have a vertical transition between the main channel and the turning basin.

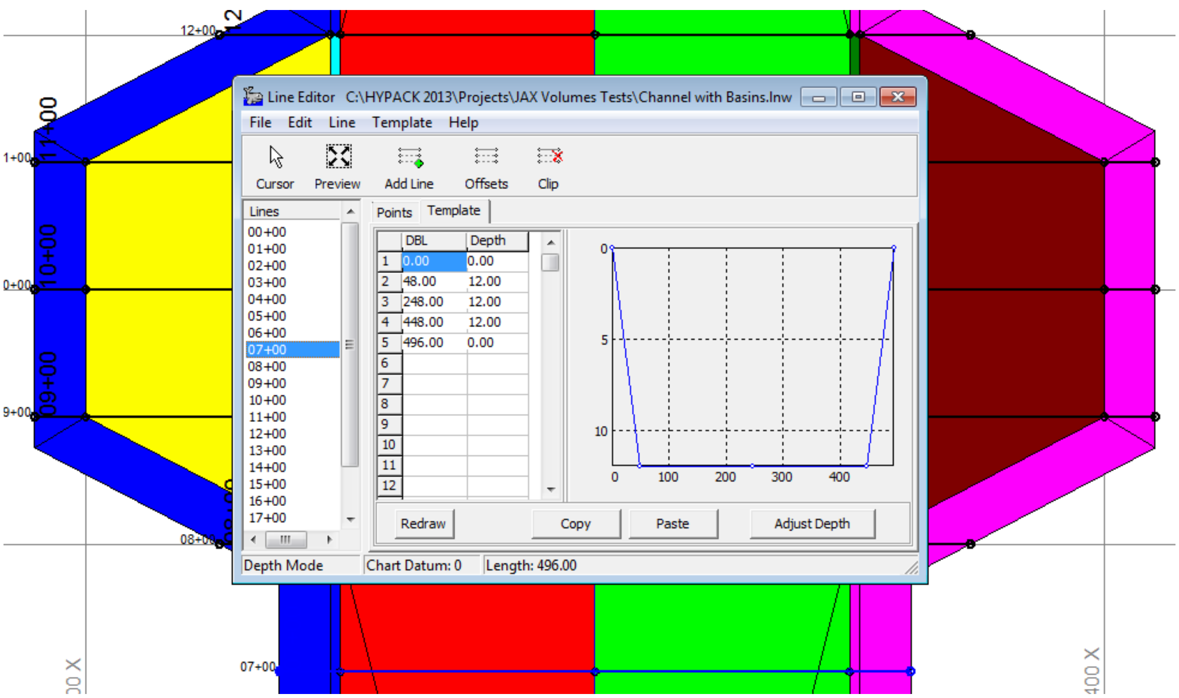
The resulting planned lines and 3D Basin are shown in the 2D and 3D View windows of CHANNEL DESIGN:

FIGURE 3. Resulting Planned Lines



Let's take a look at some of the sections that we have automatically created:

FIGURE 4. Reviewing the Channel Template—7 + 00 South of the Turning Basin



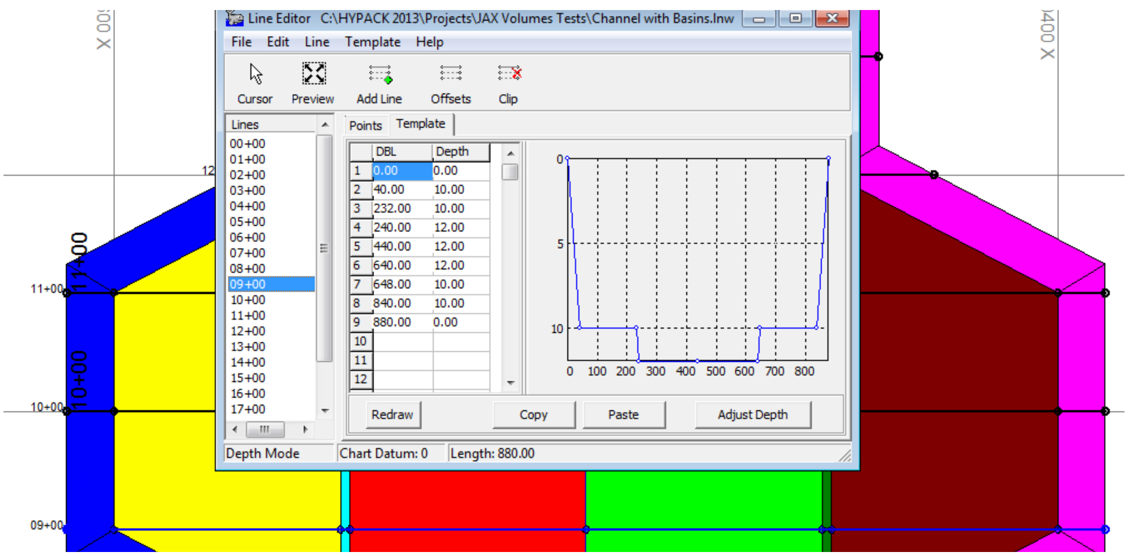
At line 07+00, we are in an area south of the turning basin. The section shown is pretty simple, with a 12’ channel with a 4:1 side slope on both sides. We’re looking at the template in the HYPACK® LINE EDITOR. It displays the DBL (distance along planned line) and depth for each template point. If you have good eyes, you’ll see the following:

DBL	Depth
0.00	0.00
40.00	12.00
248.00	12.00
448.00	12.00
496.00	0.00

The program keeps the center line point (248.0,12.0) in order to sub-divide the volumes into left-of-center and right-of-center for the main channel for the Philadelphia Method in CSV and TIN MODEL.

This is the section for line 09+00, which spans the turning basin on the left and right sides.

FIGURE 5. Reviewing the Channel Template—9 + 00 Spans the Turning Basin



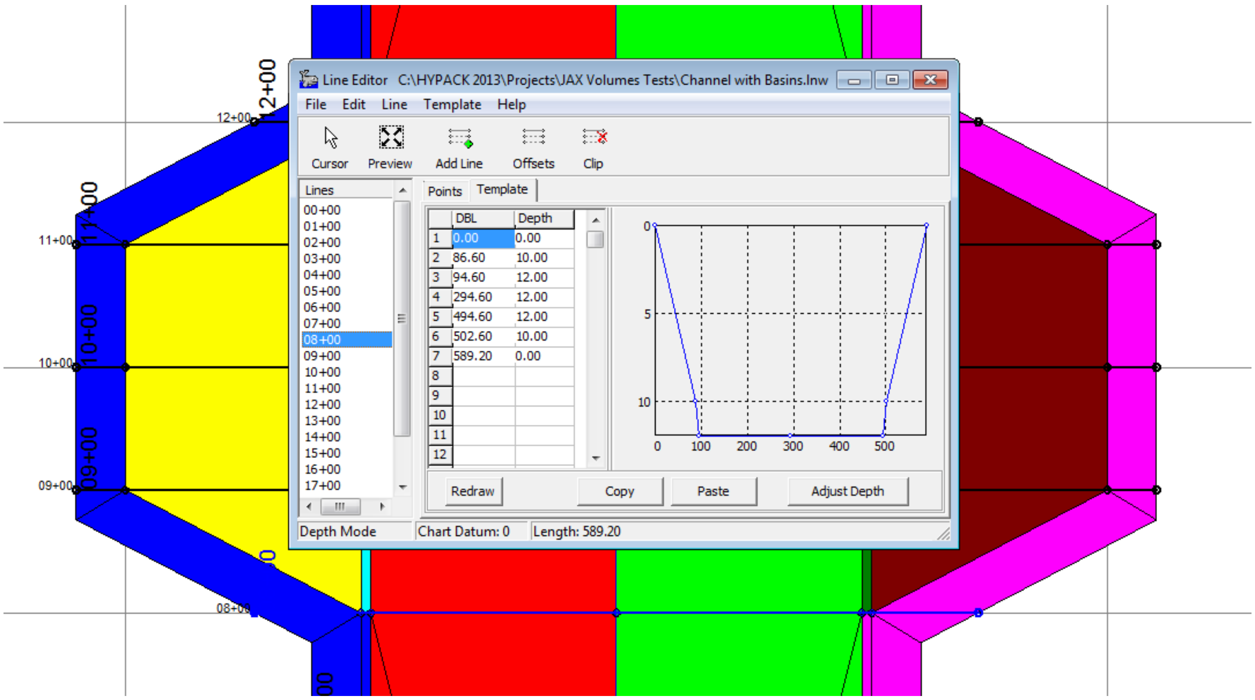
If you have good eyes, you’ll see the following points are used to define the section:

DBL	Depth	
0.00	0.00	
40.00	10.00	10’ drop on a 4:1 side slope
232.00	10.00	
240.00	12.00	2’ drop on a 4:1 side slope
440.00	12.00	centerline point
640.00	12.00	
648.00	10.00	2’ rise on a 4:1 side slope
840.00	10.00	
880.00	0.00	10’ rise on a 4:1 side slope

Since the section is perpendicular to the side slopes. It's pretty easy to figure out the section numbers and verify CHANNEL DESIGN did a good job.

Line 8+00 passes right through the point where the turning basin begins. (It's the bottom blue line on Figure 6.)

FIGURE 6. Reviewing the Channel Template—8 + 00 Spans the Turning Basin



The line passes through the transition area from the center channel to the turning basin perpendicular to the 4:1 side slope. However, it passes through the area from the turning basin up to the top of banks at an angle to the 4:1 side slope. Therefore, our first and last segments won't be 4:1 on our design section.

DBL	Depth	
0.0	0.0	
86.6	10.0	That's a 8.66:1 side slope!
94.6	12.0	A 4:1 side slope across the transition area
209.6	12.0	Centerline Point
494.6	12.0	
502.6	10.0	Transition up to the 10' turning basin.
589.2	0.0	Another 8.66:1 side slope.

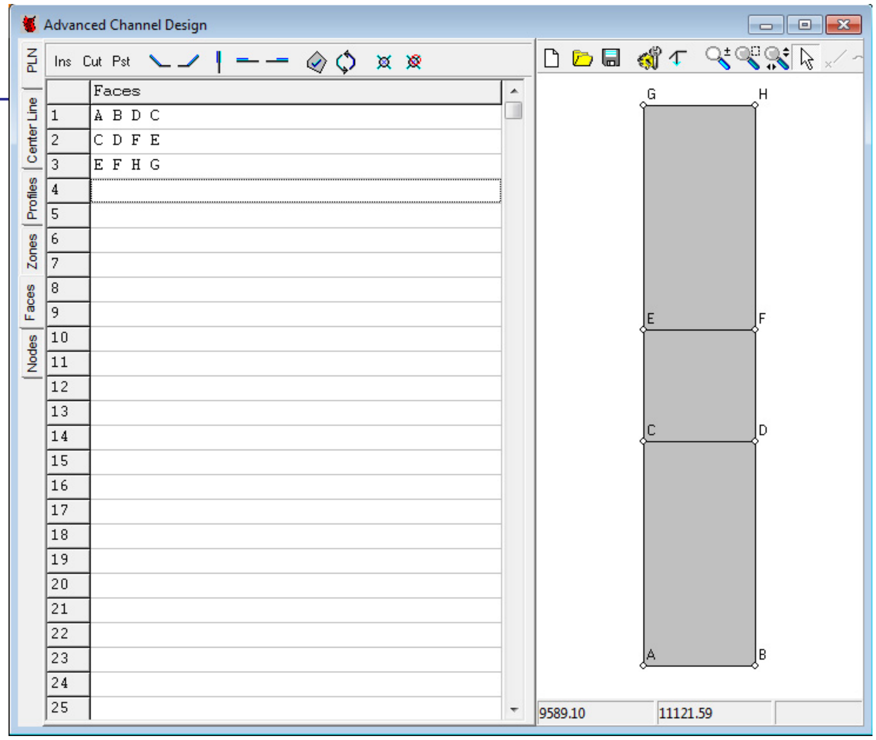
Believe it or not, that's perfect!

If you calculate volumes with lines collected with the resulting planned line (*.LNW) file, you will be limited to the methods that are available. Many calculation methods were designed for a simple channel and don't know how to handle anything else. You'll be fine if you use the Philadelphia, AEA (Average End Area) or Savannah methods.

MAKING BASINS IN ADVANCED CHANNEL DESIGN

The more I use ACD, the more I prefer it. With a little practice and a little patience, you can make just about anything!

FIGURE 7. Defining Nodes in ADVANCED CHANNEL DESIGN



1. I start off by entering the **Left Toe** and **Right Toe** point coordinates in the Nodes listing. All of the points are at a depth of 12'.

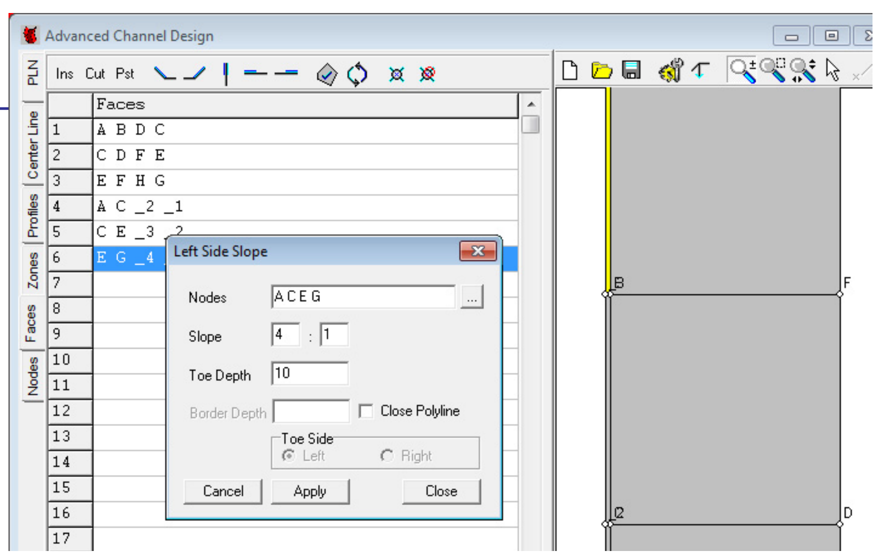
   I have created toe nodes (C, E, D, F) where the turning basins are going to start from.

   I then went into the Faces tab and created planar faces. The rules for faces are:

   - Planar
   - No concavities
   - Enter nodes counter-clockwise around the face.

2. Next, I want to create a **10' turning basin to the left** hand side. I'm going to do this in a couple of steps:

FIGURE 8. Adding a Side Slope from the Left Toe



   a. **Create a 12' to 10' slope along the entire left hand side.**

      I used the left slope icon. I told

it to create a 4:1 side slope along points A, C, E and G (the entire left toe line) and stop it at a depth of 10’.

The resulting 10’ to 8’ transition is shown in the right side of the graphic. The routine created nodes _1, _2, _3, and _4 at a depth of 10’.

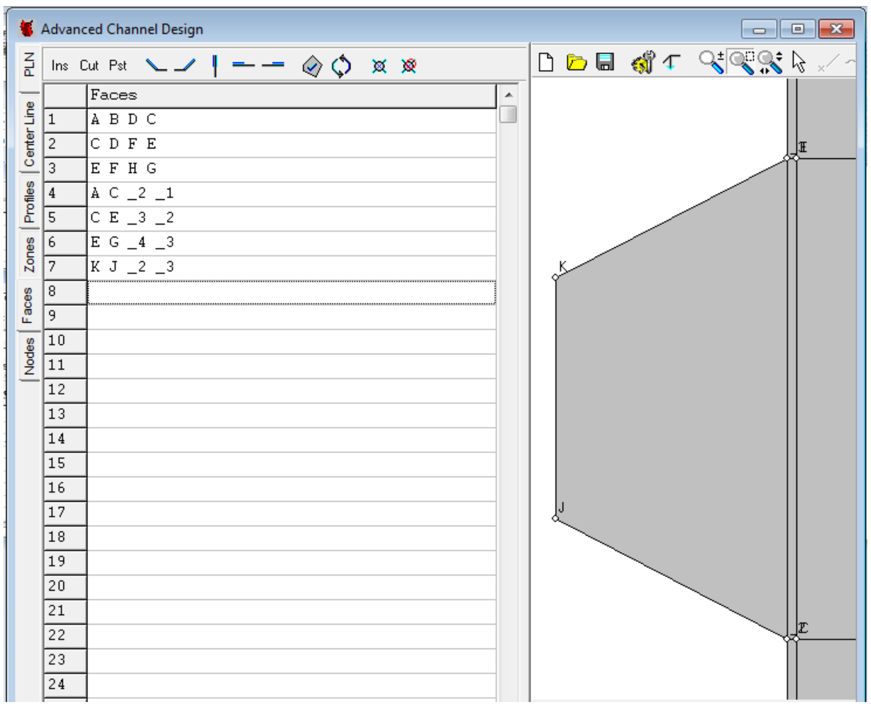
b. **Enter the Other Points to Define the Turning Basin Face**.

   i. In the Nodes tab, I entered the coordinates of points J and K with a depth of 10’ (turning basin depth).

   ii. Then, in the Faces tab, I created a planar face, telling it to connect K, J, _2, _3. That is my 10’ turning basin.

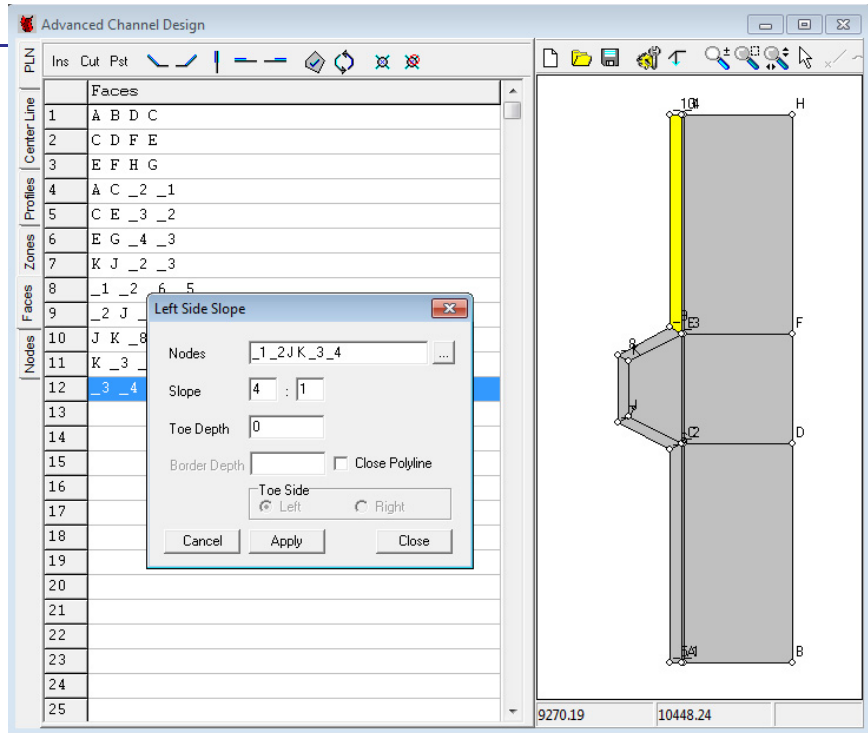
   Now the entire left edge of my figure is at 10’. I can use the left slope tool to generate a side slope from 10’ up to 0.

FIGURE 9. Describing the Turning Basin



c. **Bring the Side Slope up to your Top of Bank**.

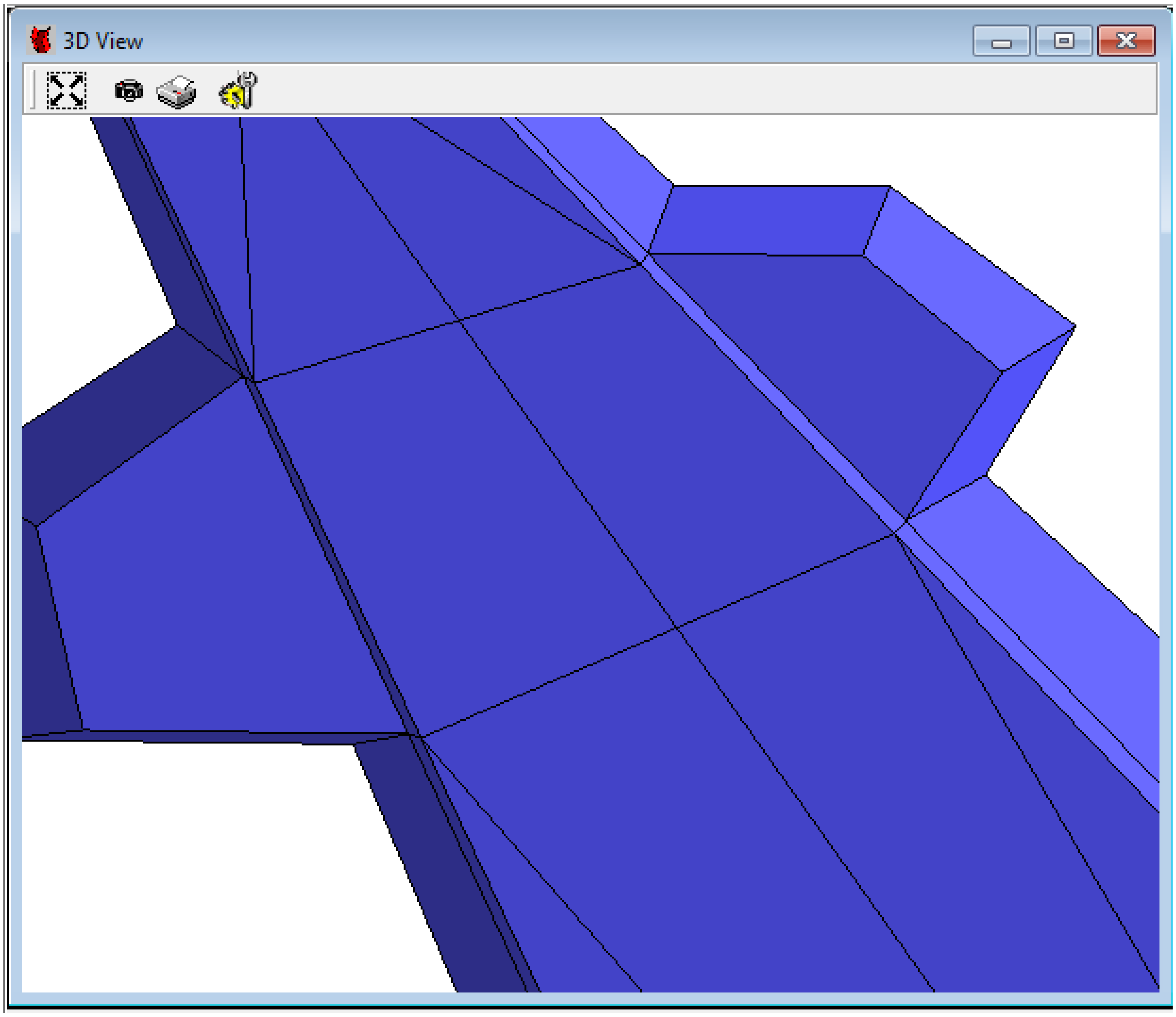
FIGURE 10.



i. Once again, I use the Left Slope tool. I tell it to create a 4:1 side slope along nodes _1, _2, J, K, _3 and _4 and to bring the slope up to a Toe Depth of 0.0. ACD will then automatically create nodes and faces to construct the side slope, as shown in the figure to the right.

3. **Create the Right Turning Basin.** The process to create the turning basin on the right side is identical. I just use the Right Slope tool instead of the Left Slope tool.

FIGURE 11. Resulting Basin Created in ACD



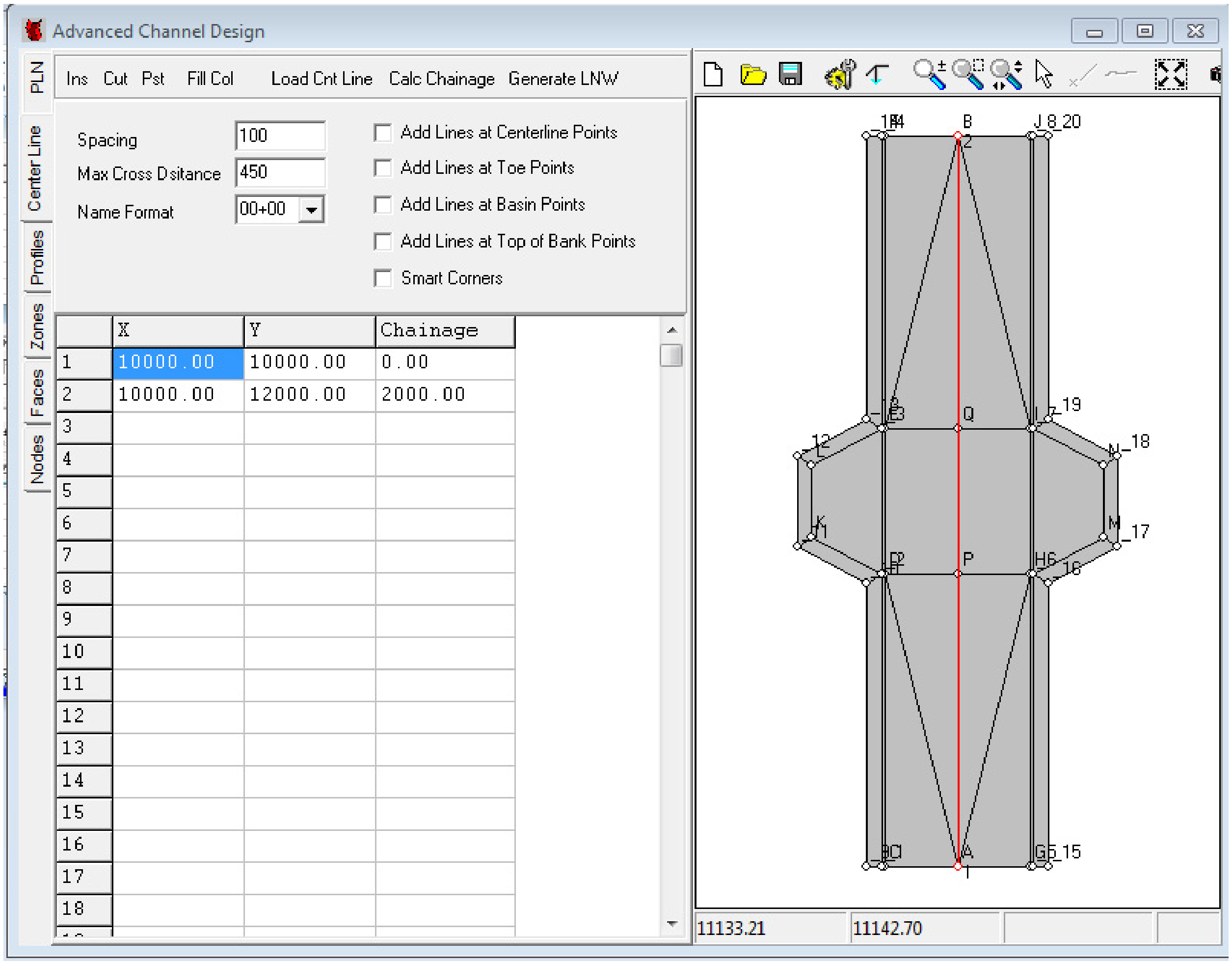
Before I exit ACD, I want to do a couple of more things.:

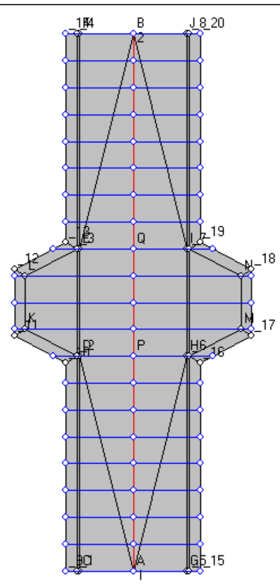
1. Define a Centerline and Create Planned Lines perpendicular to the centerline with the design section profiles.
2. Define Reporting Zones for an optional method of generating volume quantities in CSV and TIN MODEL.

CREATING PLANNED LINES FROM CENTERLINE POINTS

I'm going to manually enter my center line point coordinates and have the program compute the chainage. **Chainage** is just a distance measure along the centerline path. It doesn't have to start at 0.00.

FIGURE 12. Calculating Chainage





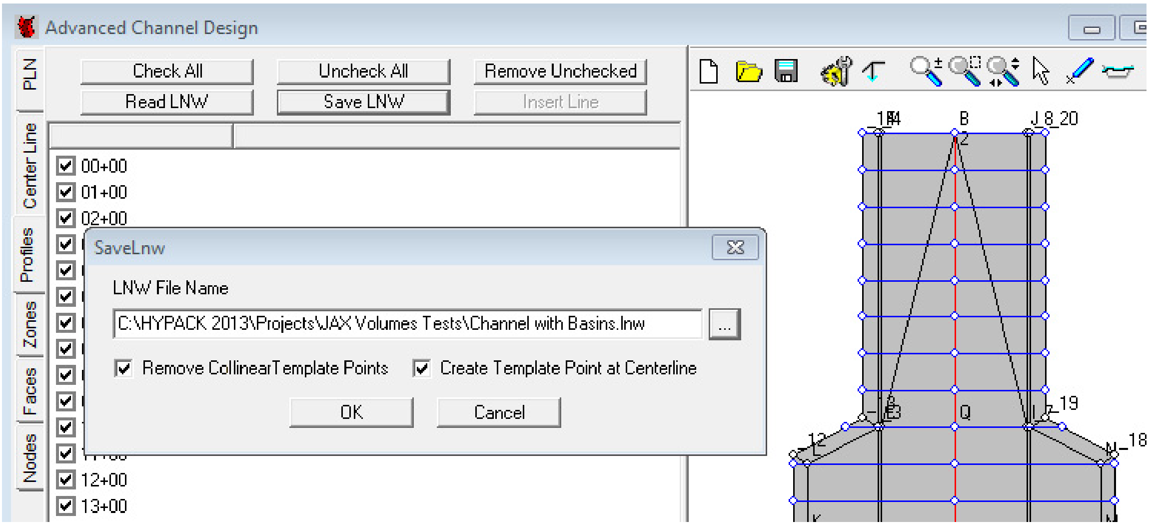
1.In the Center Line tab, I'll enter the **Spacing** (100' between sections in this example) and the **Maximum Cross Distance** (MCD).

The MCD is only necessary on complex channels that have sharp turns. It helps the program determine the geometry around turns. I know the maximum distance from my centerline outwards to my top of bank is about 400', so I have entered 450'. In my example, it doesn't really matter. If you find some weird lines around turns, try entering an appropriate value for the MCD!

I can then click on the Generate LNW menu item to create my sections.

2.**Save the lines.** Go to the Profiles tab and click [Save LNW]. (I always have to remember this one…)

FIGURE 13. *Saving Your Planned Lines*

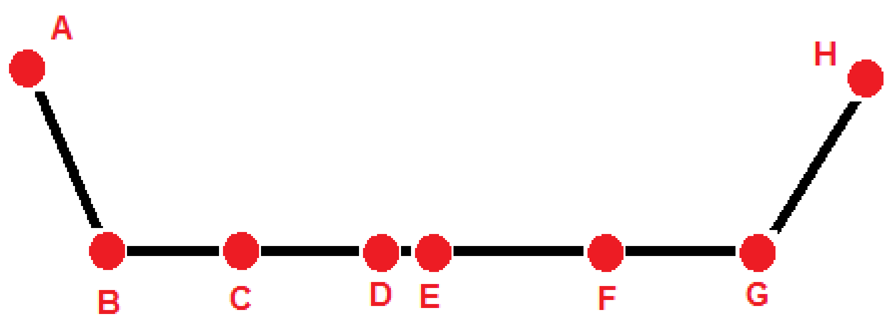


If you plan on doing volumes in CSV or TIN MODEL, you will want to check both the "**Remove Collinear Template Points**" and "**Create Template Point at Centerline**" options.

Remove Collinear Points gets rid of template points that are not needed to define the profile. **Create Template Point at Centerline** ensures that your section will have a centerline template point, allowing you to divide the volumes into left-of-center and right-of-center as in the Philadelphia methods.

In Figure 14, points B-C-D-E-F-G are collinear. I don't need all of them to define a flat profile segment.

FIGURE 14.



- **If I tell it to remove the collinear points**, I would wind up with a profile defined with A-B-G-H.
- **If I tell it to remove the collinear points *and* to create template point at centerline**, then I wind up with a profile defined by A-B-D-G-H.

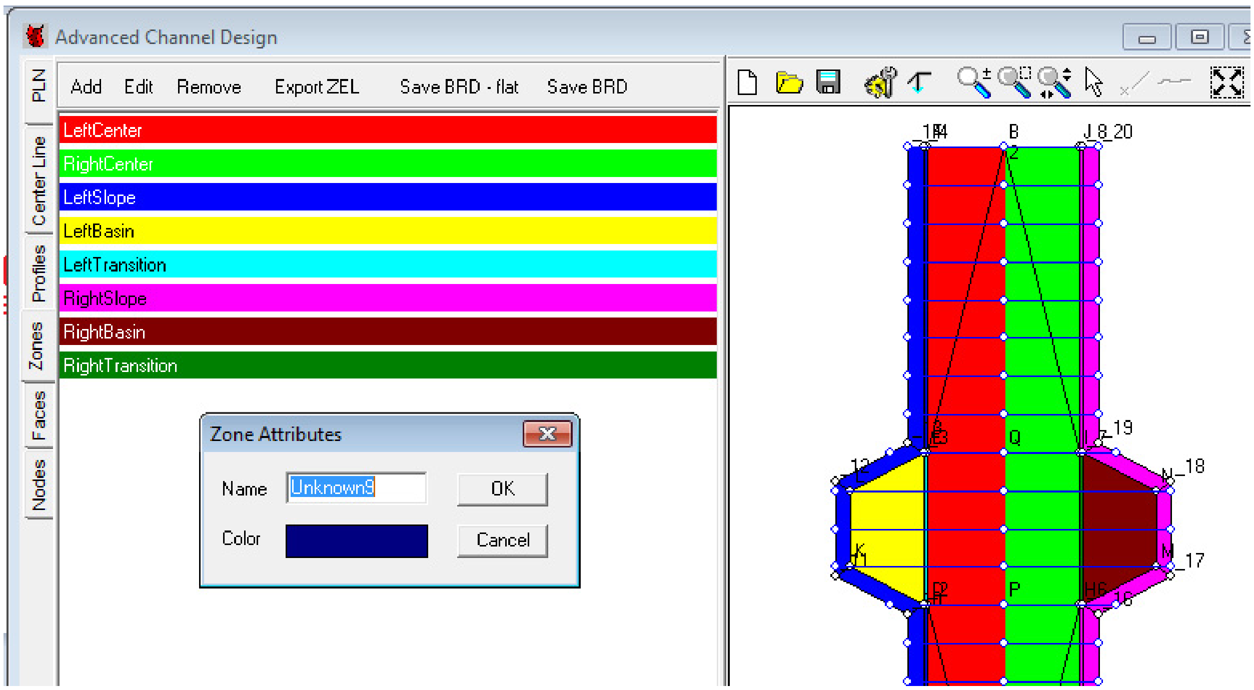
You have now prepared a planned line file that can be used to collect your data and compute volumes with the edited single beam data in CSV. You could also take your resulting XYZ file from a multibeam survey, load it into TIN MODEL and cut sections using the LNW file and then calculate volumes in CSV.

Creating Reporting Zones

By clicking the “Zones” tab, we can create separate reporting zones that can be used when computing volumes in CSV or TIN MODEL.

1. **Create your zones by clicking [Add]**.
2. **Give your zone a name and click [OK]**. I set up 8 reporting zones in this example:

FIGURE 15. Eight Reporting Zones in the Sample Channel



- Left Center (Red)
- Right Center (Green)
- Left Slope (Blue)
- Left Basin (Yellow)
- Left Transition (Light Blue)
- Right Slope (Purple)
- Right Basin (Brown)
- Right Transition (Dark Green)

3. **Assign each face to a zone**.
   a. **Select the arrow icon**.
   b. **Click on one of the zones in the list on the left**.
   c. Click on each face in the graphic on the right to assign it to the selected reporting zone.
4. **If you are going to do volumes in TIN MODEL, just save the CHN file**.
5. **If you are going to do volumes in CSV, create a Zone Edge List (*.ZEL) file**.
   a. **In the Profiles tab, click [Read LNW button] and read a planned line file**.

Note: If you made a planned line file in ACD using the Center Line option, you can skip this step as you already have your lines entered.

b. **In the Zones tab, click [Export ZEL] and give your Zone Edge List file a name.** It will append a *.ZEL extension to it.

The *.ZEL file contains information where each planned line crosses a reporting zone and any change of depth inside a reporting zone.

When you run volumes in CSV, you will use the *.ZEL file as your Template file:

1. Select the Zone Listing Predredge or Zone Listing Postdredge method.
2. Enter the ZEL file in the Template column and fill the column so the *.ZEL file is listed for every profile.

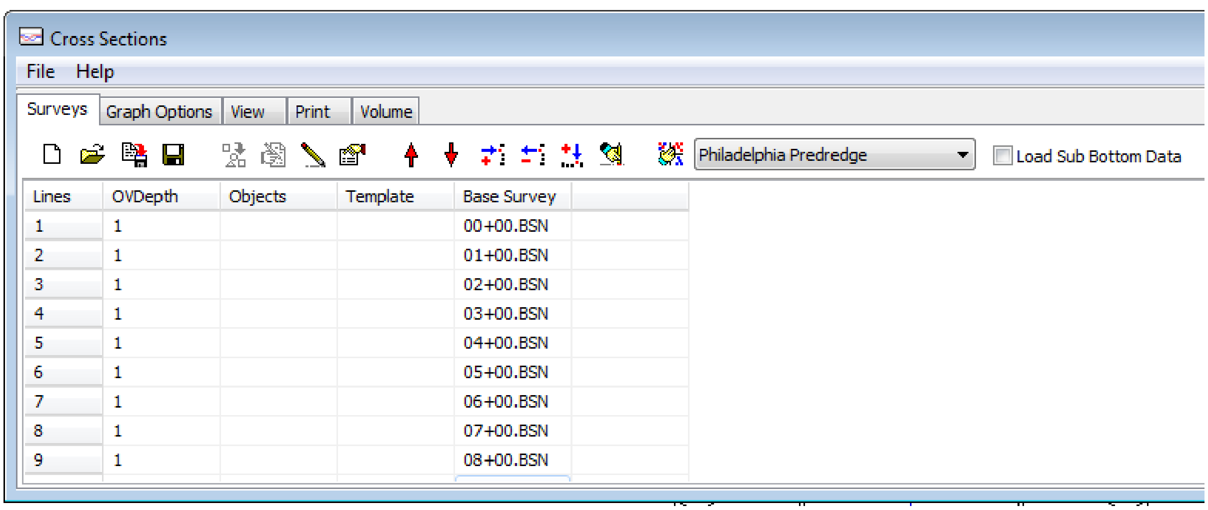
VOLUMES IN CROSS SECTIONS AND VOLUMES (CSV)

Here are a couple of examples of computing volumes with a turning basin in CSV. We'll look at the Philadelphia and the Zone Edge Methods.

PHILADELPHIA PREDREDGE METHOD

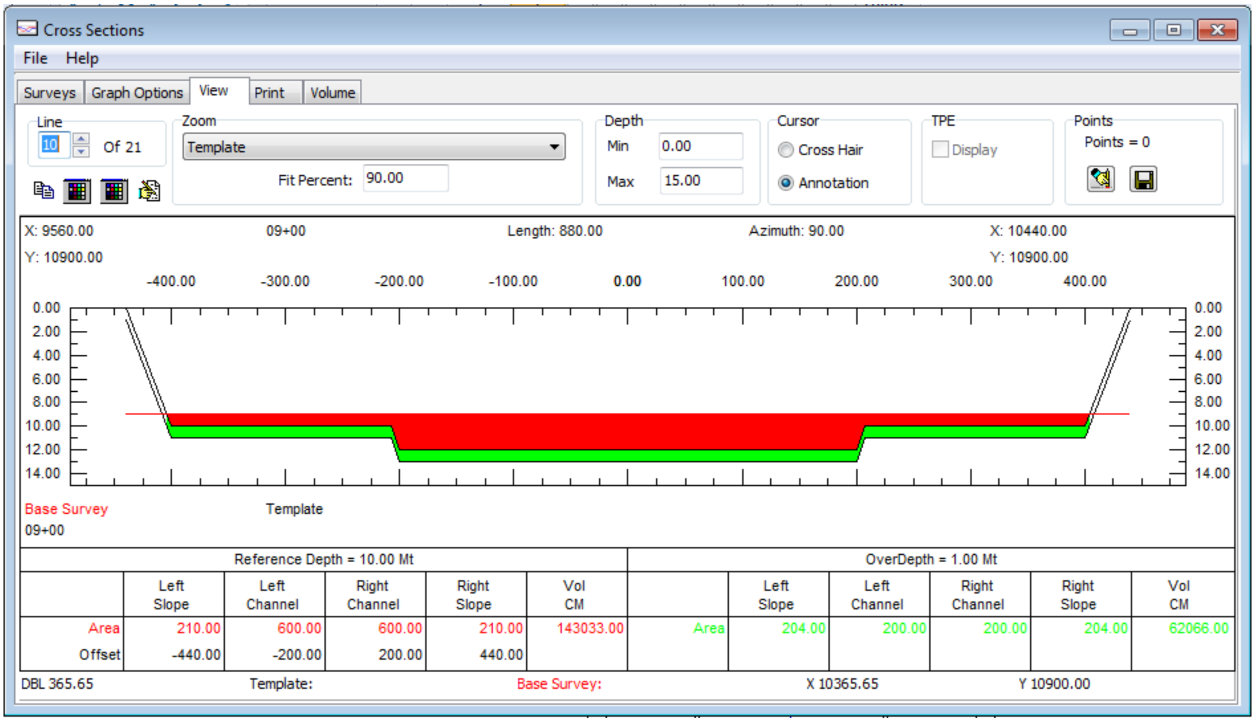
I've set up CSV for the Philadelphia method. I enter my Edited ALL Catalog file under the Base Survey column (yours might have a different label) and the program lists the files. I entered 1' as the OVDepth (Overdepth Template offset). I don't have to enter any templates, as they are embedded in the headers of the data files.

FIGURE 16. Philadelphia Predredge Volume Calculations in CSV



You would want to check the settings under the Graph Options – Volume tab, as the Philadelphia Method has a lot of options that can REALLY affect your volume results.

FIGURE 17. Line 09+00 Extends Through each Turning Basin



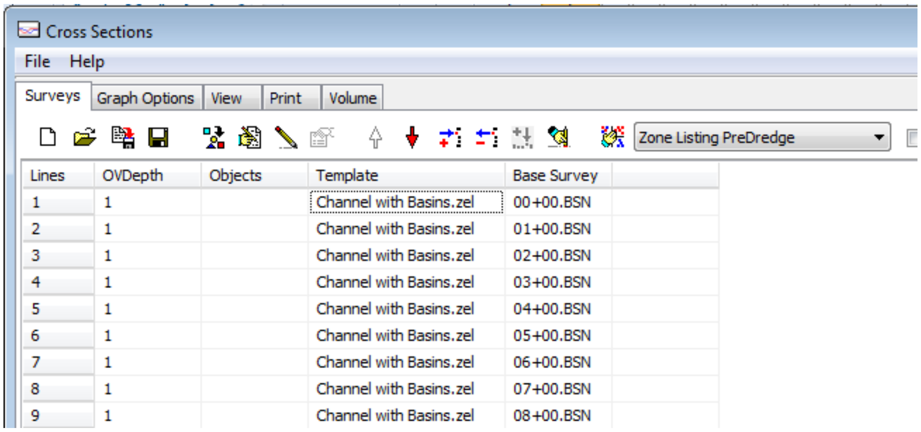
The volume summary is at the top of the report, followed by information for each survey profile.

```
Station To Station     Project    Over       Left       Right
                       Depth      Depth      Slope      Slope
00+00    20+00         12.00      13.00      4.00\1     4.00\1
Dredging Quantities Summary
===========================
Total Material To Project Depth ...............2588132.00 CM
Total Allowable Overdepth ..................... 965064.00
Total Pay Place ...............................3553196.00
```

Zone Listing Method

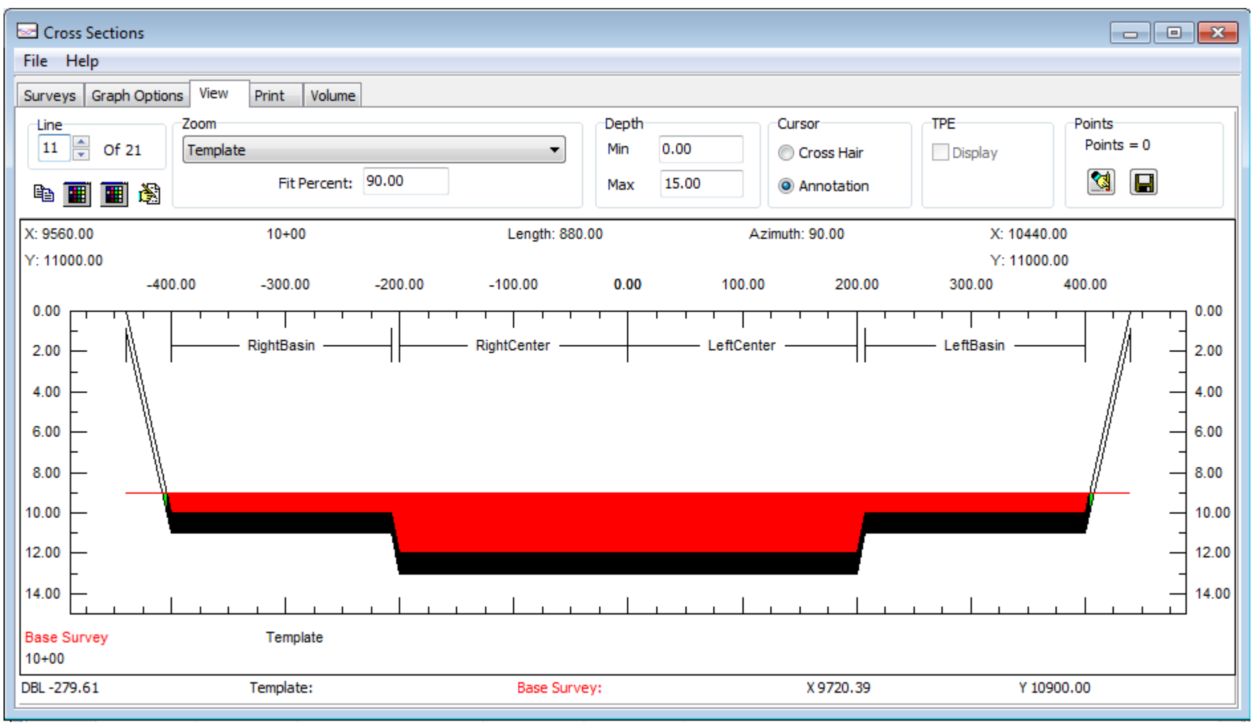
I've selected the Zone Listing Predredge method and entered my edited *.LOG file, an Overdepth of 1' and the name of my Zone Edge List (*.ZEL) file that we created in ACD.

FIGURE 18. Zone Listing Predredge Volume Calculations in CSV



There are no options in the Graph Options – Volume tab! The section across the turning basin is shown in Figure 19:

FIGURE 19. Section 10+00 Profile in CSV



Notice how it labels each reporting area. If it doesn't have enough space for the label, it omits it.

TABLE 1. The Summary from the Volume Report

Volume Report Plan: Method: Zone Listing 3/8/2013 2:10:56 PM
Areas: Sq Meters, Volumes: Cu Meters

	Design	Overdepth	Contour OD
RightSlope	30066.00	26198.00	21732.00
RightBasin	57600.00	57600.00	57600.00
RightTransition	6400.00	3200.00	3200.00
RightCenter	1200000.00	400000.00	400000.00
LeftCenter	1200000.00	400000.00	400000.00
LeftTransition	6400.00	3200.00	3200.00
LeftBasin	57600.00	57600.00	57600.00
LeftSlope	30066.00	26198.00	21732.00
Totals	2588132.00	973996.00	965064.00

The results are exactly the same as the Philadelphia Method! That is only true because I was very careful when I set the options for the Philadelphia Method under the Graph Options-Volumes tab.

VOLUMES IN TIN MODEL

When I make my TIN MODEL, I specify the name of my CHN file created in ACD and a planned line file. The planned line file is necessary if you want to subdivide your volume report by pairs of planned lines. TIN MODEL ignores any template data in the planned line file and rely entirely on the 3D geometry of the CHN file to determine the volume quantities.

FIGURE 20. Generating a TIN Model with Channel and Planned Line Information

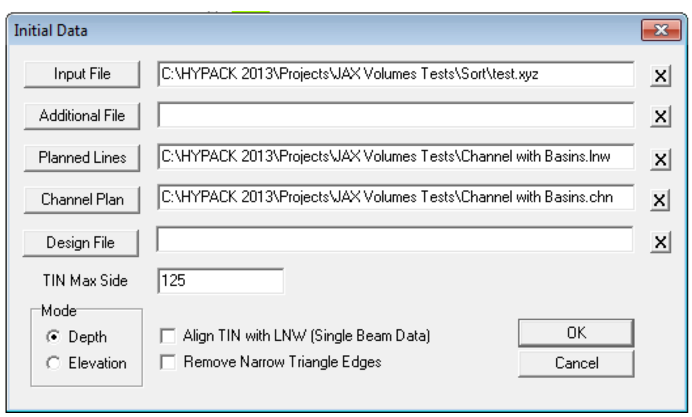
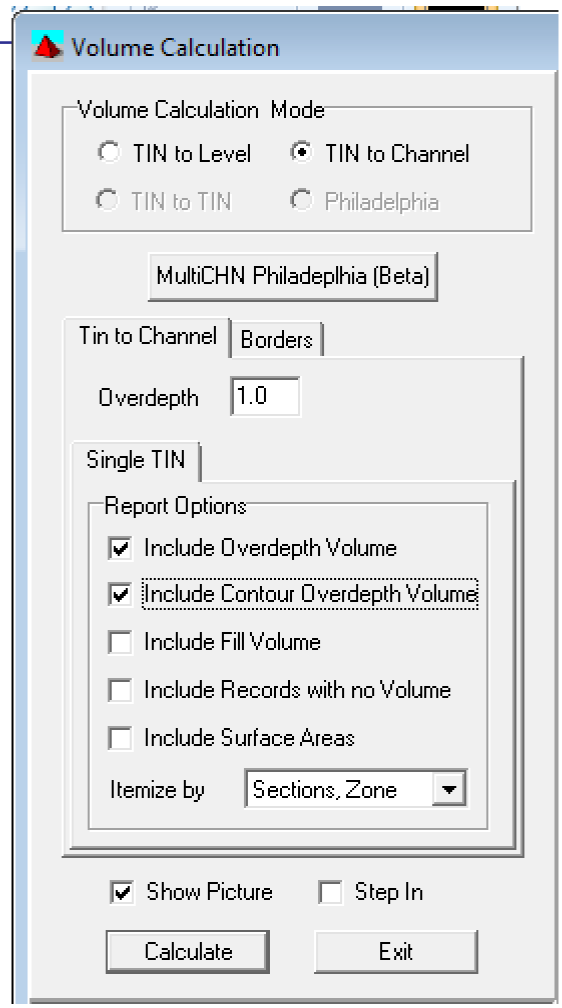


FIGURE 21. Calculating Volumes in TIN MODEL



After selecting CALCULATE – VOLUMES, I set the **Volume Calculation Method** to TIN-to-Channel and the **Overdepth** to 1.0’ below the CHN surface.

There are options to include the Overdepth, the Contour Overdepth, the Fill Volumes and other items in the report. I’m just going to compute the material above design, along with the Overdepth and the Contour Overdepth.

The last thing is the **Itemize by**. If we select **Zones**, it will just give the total summary of material for each reporting zone. If we select **Sections, Zones**, it will subdivide the report for each pair of planned lines and show how much each of each material lies in each zone.

Totals:

LeftCenter	1201580.0	400526.7	400526.7
RightCenter	1200000.0	400000.0	400000.0
LeftSlope	29481.1	25847.0	21381.0
LeftBasin	57600.0	57600.0	57600.0
LeftTransition	6400.0	3200.0	3200.0
RightSlope	30066.0	26198.0	21732.0
RightBasin	57600.0	57600.0	57600.0
RightTransition	6400.0	3200.0	3200.0
Accum. Total:	2589127.1	974171.6	965239.7

You’ll notice that the resulting numbers are slightly different than the ones computed in CSV. Not a lot, but a little. That is because CSV doesn’t know anything that happens with the channel geometry between the two profiles. TIN MODEL, using a CHN file, knows exactly what happens. Therefore, I prefer to use TIN MODEL for almost all volume computations!

The End.