



A Rambling Piece on Volume Quantities

By Pat Sanders

I recently had to explain to a HYPACK® user why it wasn't a good procedure to determine the volume of material removed by separately computing the pre-dredge and post-dredge volumes and then taking the difference between them. For our example, let's look at the following real-world results, obtained from the HYPACK® TIN MODEL program:

TABLE 1. *TIN MODEL Volume Calculation Comparison*

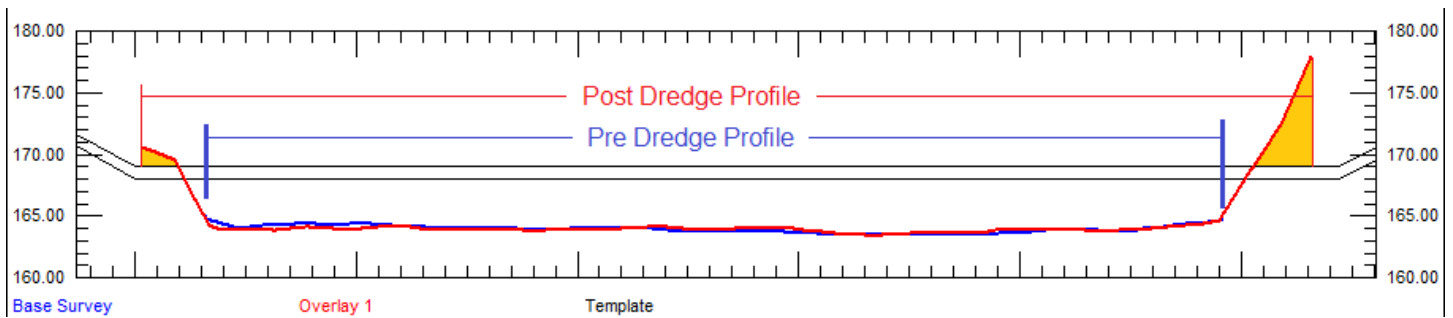
	Pre-dredge Volumes (yd ³) (Philadelphia PreDredge Method)	Post-dredge Volumes (yd ³) (Philadelphia PreDredge Method)	Numerical Difference (yd ³) (Pre-dredge Minus Post- dredge)	Pre-vs-Post using Philadelphia Post-dredge Method (yd ³)
Material Above Design	30,625	1,201	29,424	30,281
Material in Allowable Overdepth (Contour)	22,784	2,472	20,312	13,754
Total Material	53,409	3,673	49,736	44,036
Remaining Material Above Design		1,201		395

Keeping the above numbers in mind, let's allow the conversation to proceed...

There's something wrong with your volume computation. It's cheating me out of over 5,000 cubic yards! If I compute the material based on my pre-dredge survey, I get 53,409 yd³. If I compute the material based on my post-dredge survey, I get 3,673 yd³. Take the difference between them and it proves I removed 49,736 yd³. When I run your Philadelphia method in TIN MODEL with both the pre-dredge and post-dredge data sets, it reports I only removed 44,036 yd³! There's obviously something wrong with your #@&*% program.

Whoaaaa... Let's start off with your Material Above Design. When we run the Philadelphia method in TIN MODEL with a pre-dredge and a post-dredge file, it only computes the differences in material where the two data sets overlap. Let's cut a section through your data sets, bring the results up in CROSS SECTIONS AND VOLUMES and take a peek...

FIGURE 1. Pre-dredge vs Post -dredge in CROSS SECTIONS AND VOLUMES



Note that the post-dredge profile extends a little further in both directions than the pre-dredge profile. If I compute the volume separately for the pre-dredge and the post-dredge, then the pre-dredge report would show no material and the post-dredge report would reflect the material shown with the yellow infill. If I just take the numeric difference between them, I'm going to come up with a negative value for my material removed (in this case).

When I bring the pre-dredge and post-dredge surveys both into the TIN MODEL and ask it to compute the volume of material removed, it only will perform the calculations where the two data sets overlap. In the above case, the data from the post-dredge profile that is located outside the span of the pre-dredge profile would be ignored. So, for the above profile, the pre-dredge material would be zero and the post-dredge material would be zero.

So, let's take a look at your Material Above Design numbers:

TABLE 2. Contour Volume Calculations--Pre-vs-Post-Dredge Calculations vs Numerical Differences:

Type of Computation	Cubic Yards (yd ³)
Pre-Dredge Survey Only:	30,625
Post-Dredge Survey Only:	1,201
Numerical Difference:	29,424
Pre-Versus-Post Result:	30,281

In your case, your post-dredge survey covers a little bit more territory and has survey results from some regions that are not included in your pre-dredge survey. The pre-vs.-post routine in TIN MODEL (and CROSS SECTIONS AND VOLUMES) is going to only compute quantities where the two data sets overlap. To illustrate this, let's cut the post-dredge surface model with a border file that was created from the coverage limits of the pre-dredge survey. Then, we'll see how the results compare.

How do you do that?

FIGURE 2. Post-dredge Data Set Extends Beyond the Limits of the Pre-dredge Border File

Good question.

1. Load the pre-dredge data file into the TIN MODEL.
2. Export a HYPACK® border (*.BRD) file that represents the perimeter of the pre-dredge data file.
3. Load the post-dredge data file into the TIN MODEL.
4. Use the Modify TIN routine to trim it to the pre-dredge border.
5. Compute the quantities!

OK. I can buy that. What do you get?

Now when we look at the comparison, it should make a little more sense.

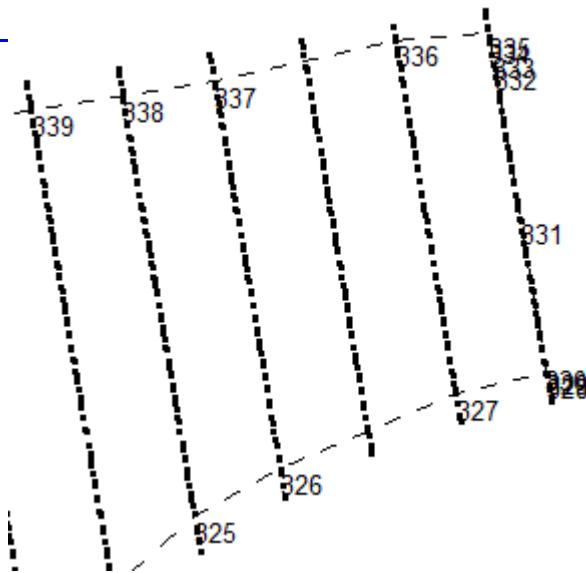


TABLE 3. Recalculating the Volumes Using Post-dredge Data Trimmed to the Extent of the Pre-dredge Data.

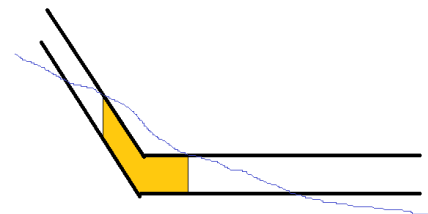
Type of Computation:	Material Above Design (yd3)
Pre-dredge Survey Only:	30,625
Post-dredge Survey Only, Trimmed with Pre-Dredge BRD:	411
Numerical Difference:	30,213
Pre-Versus-Post Result:	30,281

So, keep in mind when you do a Philadelphia Pre-versus-Post in the TIN MODEL, it only computes quantities where the two data sets overlap.

OK. But look at the Allowable Overdepth Material. How the hell can you explain over 7,000 yd³ difference? That can't be because of some small overlap thing. You're costing me big money here and my attorney is going to be calling you.

Let's hope he had a minor in mathematics.... OK. I see that you were using the 'Contour' method to compute your overdepth material. This means that material in the Allowable Overdepth region is only included in the volume quantities if the bottom profile is above the channel design limit. In Figure 3, if you had the 'Contour' option selected, only the yellow-shaded region would be computed as Allowable Overdepth.

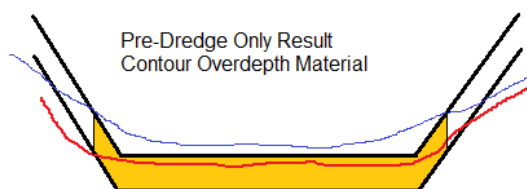
FIGURE 3. Pre-dredge Profile



Let's first take a look at the pre-dredge profile (Figure 4).

FIGURE 4. Pre-dredge Profile

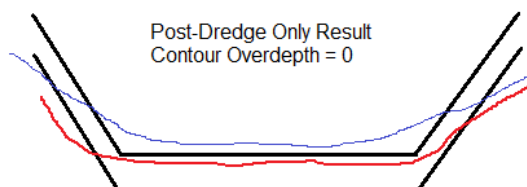
The blue line represents my pre-dredge profile. If I compute the volume quantities on just the pre-dredge survey (using the Contour option), all of the material shown in yellow would be reported as Allowable Overdepth .



Next, let's take a look at the post-dredge profile.

FIGURE 5. Post-dredge Profile

In Figure 5, the entire post-dredge profile is beneath the channel design limit. Therefore, using the Contour option, the reported Allowable Overdepth would be zero!



If you just take the numeric result, you would get credit for removing all of the Allowable Overdepth found in the pre-dredge survey! So, you're getting credit for removing all of the Allowable Overdepth material, even when you may have just removed a little bit beneath the channel design template!

FIGURE 6. Pre-dredge minus Post-dredge Contour Calculations -- Numeric Difference

When you compute the volume quantities between pre-dredge and post-dredge data sets, using the Contour method in either the HYPACK® TIN MODEL or CROSS SECTIONS AND VOLUMES program, both programs will report only the Allowable Overdepth material found in the pre-dredge survey that has been removed. This can result in some VERY different results than if you just take the numerical differences between the pre-dredge and post-dredge results.

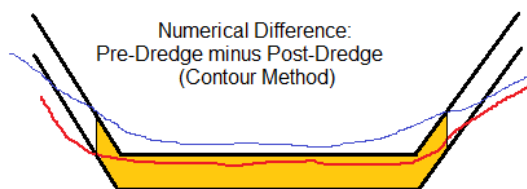
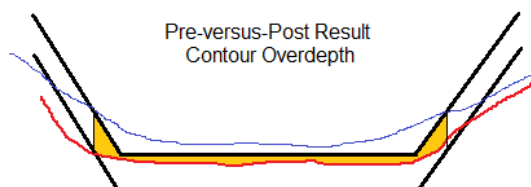


TABLE 4. Numerical Difference vs Pre-vs-Post-Dredge Calculations

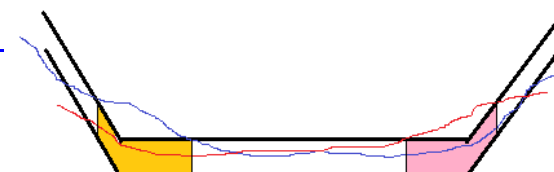
Type of Computation	Contour Overdepth (yd ³)
Pre-Dredge Survey Only:	22,784
Post-Dredge Survey Only:	2,472
Numerical Difference:	20,312
Pre-Versus-Post Result:	13,754

FIGURE 7. Pre vs Post-Dredge Contour Overdepth



So, if I just take the numerical difference between the pre-dredge and post-dredge results, and am using the Contour Overdepth method, I'm going to wind up getting a much bigger number for my Allowable Overdepth?

FIGURE 8. Numerical Difference vs Pre- vs Post-dredge Calculations



Usually. Especially if the post-dredge survey shows they have dug just below the Project Design depth! One other reason not to take the numerical difference is that the region available for the Contour Overdepth is defined by the pre-dredge survey. If you compute just the pre-dredge (blue profile) Contour Overdepth, you wind up with the material shown in yellow. If you compute just the post-dredge (red profile), you wind up with the material shown in pink. Taking the numerical difference would pretty much wind up with zero. However, in a pre-vs-post computation, the region for computing Contour Overdepth is determined by the pre-dredge survey. Only the region encompassed by the yellow material would be eligible for consideration of Contour Overdepth and the pink region from the post-dredge survey would not show up as Allowable Overdepth. It would show up as Infill!

Ouch. My head is hurting. So, which way is right?

Did you read any of the above stuff? The pre-versus-post results are a much more accurate reflection of the material that has been removed than just taking the numerical difference between the pre-dredge and post-dredge results.

What if I used the Non-Contour method where all of the Allowable Overdepth is computed?

Then the discrepancies between the 'Numerical Difference' and the pre-versus-post won't be so large. You will still get some differences due to different coverage. In our example, I reran the volumes using the Non-Contour option for Allowable Overdepth and got the following:

TABLE 5. *Non-Contour Volume Calculations--Pre-vs-Post-Dredge Calculations vs Numerical Differences*

Type of Computation	Contour Overdepth (yd ³)
Pre-Dredge Survey Only:	27,695
Post-Dredge Survey Only:	12,054
Numerical Difference:	15,641
Pre-Versus-Post Result:	15,821

So, the total Allowable Overdepth removed is greater when you use the Non-Contour method! Is that always true?

The Non-Contour Allowable Overdepth is almost always greater, or in a few rare circumstances, the same as the Contour Allowable Overdepth. It should never be less.

What if we did all of this in CROSS SECTIONS AND VOLUMES, computing quantities using sections?

I did all of the above using CROSS SECTIONS AND VOLUMES (CSV) and all of the results are VERY SIMILAR to the TIN MODEL results. That won't always be the case, but the bottom here was pretty uniform between sectional profiles.

TABLE 6. *Volumes Calculations--TIN MODEL vs CROSS SECTIONS AND VOLUMES*

Pre-versus-Post Results	TIN MODEL (yd ³)	CROSS SECTIONS AND VOLUMES (yd ³)
Material Above Design	30,281	30,313
Allowable Overdepth (Contour)	13,754	13,850
Total:	44,036	44,163

OK. So, maybe your volume programs aren't so bad after all. Where can I learn more about doing volumes in HYPACK®?

Read the training materials. Then try to attend the next HYPACK® Volumes Seminar. It's a two-day hands-on seminar where we go through a lot of stuff and show you how different options can affect your volume results. It costs \$750.

That's a lot of money...

Not as much as 5,000 yd³ x \$6 per yard.....

"The End"