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## TIN to Level – An Understanding of Reservoir Volumes

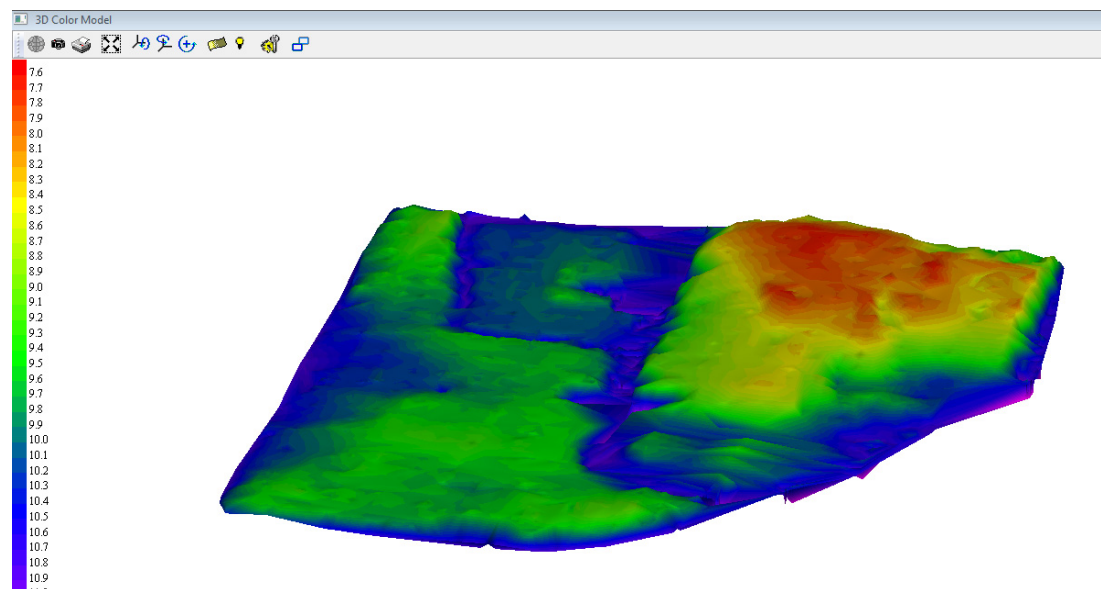
By Christian Shaw

Here in the Support Department, we get many questions on the TIN-to-Level volume calculation method. This is a very simple volume method that is very misunderstood as to what it is actually computing. In its most basic function, this method is computing cut and fill volumes about different user-defined levels.

For reservoir volumes, we are interested in water that fills the void up to a user-defined level. In my example below, I will illustrate what the program is computing when calculating how much water is between two different levels. I will start with computing how much water is from the water surface to the bottom of the survey and also compute how much water would be required to fill to a level of 10.

The important part of this volume method visually understanding where the volume is being derived from. Let's take a look.

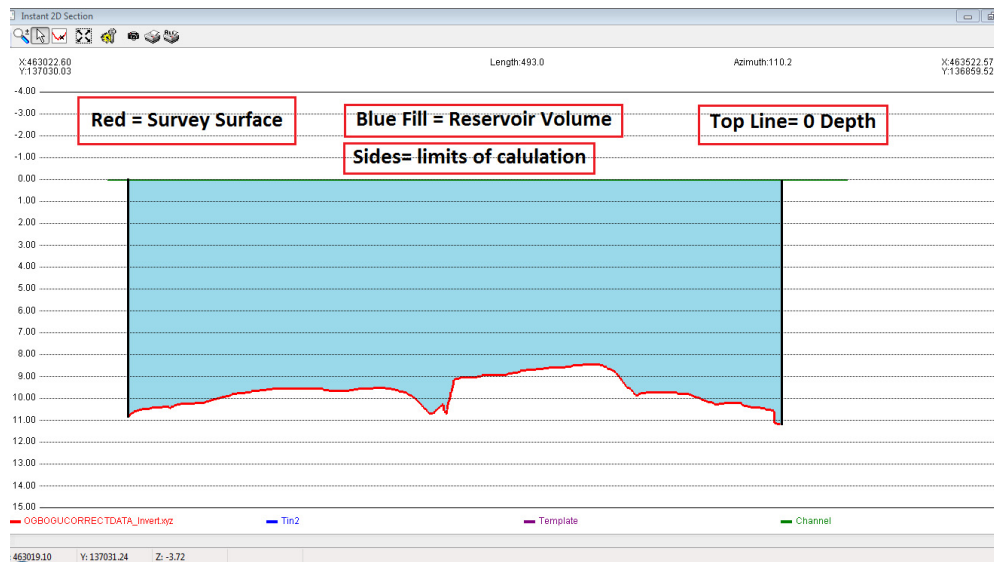
**FIGURE 1. TIN 3D Color Model**



### ***TIN SURFACE TO LEVEL = 0 (WATER SURFACE)***

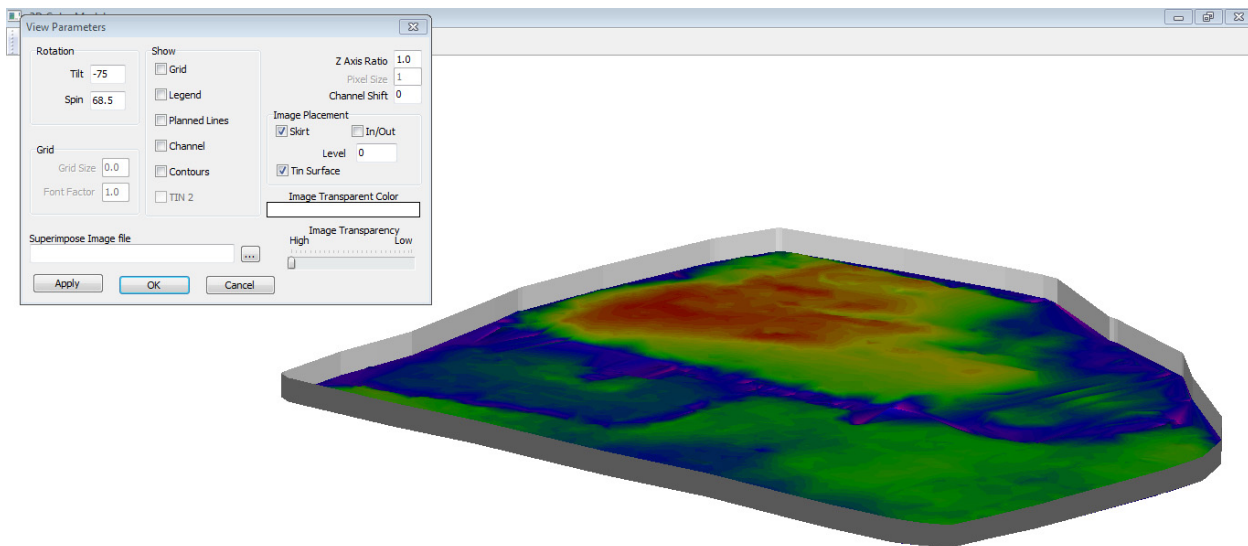
This survey is typical. Depths for this area are from 7.6 down to +/-11.5 . The whole idea is to calculate how much water there is from the current survey surface to the water surface line at 0.

**FIGURE 2. TIN 2D Section**

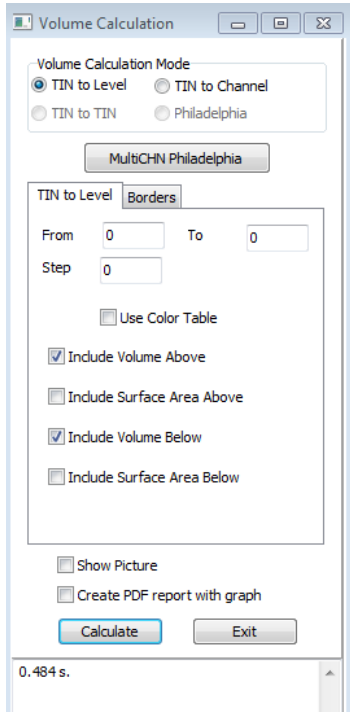


Let's look at this data in the TIN 3D Model Window:

**FIGURE 3. TIN 3D Model Window**

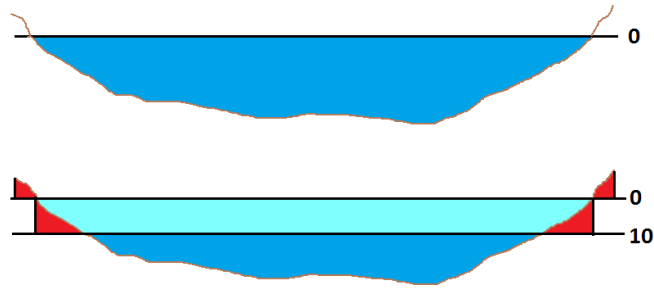


In the 3D Model color we can Skirt the Surface to an elevation. This gives the best view. If you were to fill from the top of this skirt to the bottom surface, this would be your reservoir volume from the water surface down.



In the Volume Calculation dialog (TIN- CALCULATE VOLUME), here are the simple settings for the reservoir volumes. You can see that the “From”, “To” and “Step” fields are all 0. This sets the program to only compute one level—Level 0. In this case, it computes the volume from the water surface down to the survey surface and also (if any) how much material we would have to scrape off to bring the survey surface down to the 0 level.

**FIGURE 4. TIN-to-Level 0 Calculations**

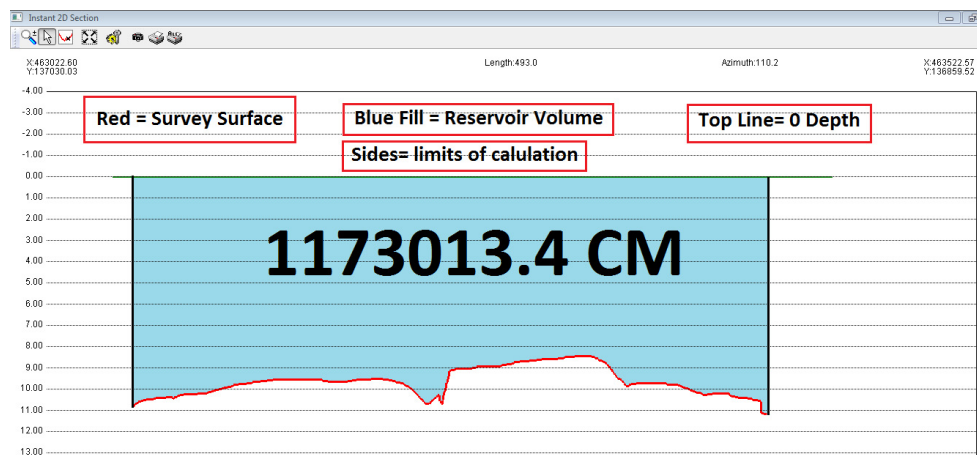


Let’s look at the volume report:

| TIN vs Level Volume Totals                                                             |              |              |
|----------------------------------------------------------------------------------------|--------------|--------------|
| Volume unit: Cubic Meter                                                               |              |              |
| TIN File: C:\HYPACK 2017a\Projects\Generic Volumes\Sort\OGBOGU CORRECT DATA_Invert.xyz |              |              |
| Level                                                                                  | Volume Above | Volume Below |
| -----                                                                                  | -----        | -----        |
| 0.00                                                                                   | 0.0          | 1173013.4    |

The volume report tells us that 1,117,013.4 cubic meters of water fills the void from the water surface to the bottom (survey surface).

**FIGURE 5. 2D Section of your TIN-to-Level Calculation—Level=0**

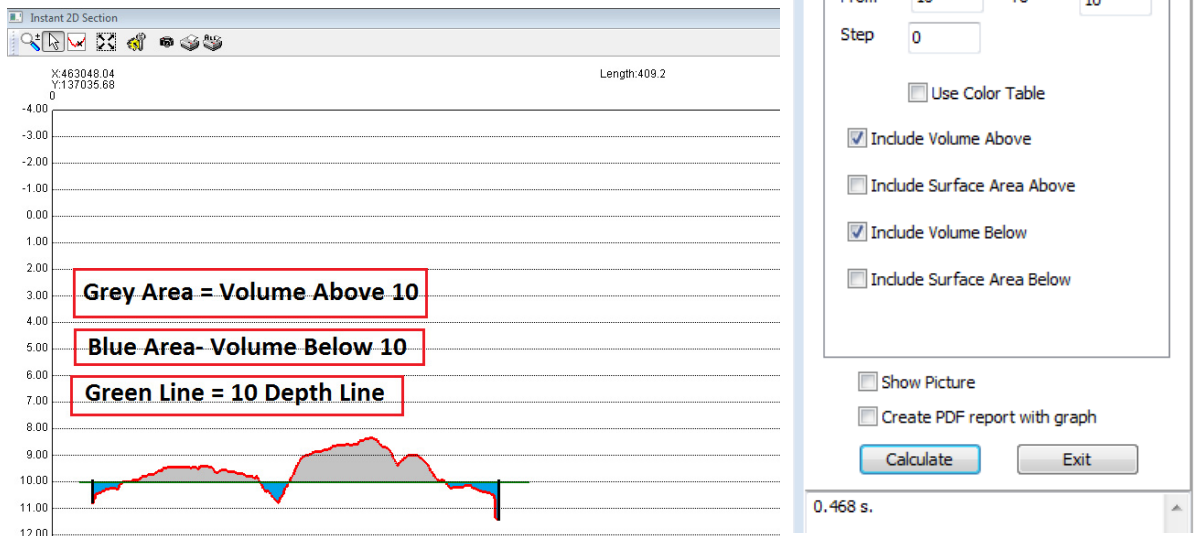


## TIN SURFACE TO LEVEL = 10

We can take this one step further to get a better look at the volume report. What if there is Volume Above and Volume Below? Which one do I choose? This is where this volume method really hangs people up!

Let's take a look at what happens when I compute reservoir volumes to a level of 10. Where would the water be added?

**FIGURE 6.** 2D Section of your TIN-to-Level Calculation—Level=10



You can see in Figure 6 that, because most of the surface is above 10, there is little water to be added; it only fills in the small voids below the 10 meter level. Graphically things seem OK. What is the volume report showing us? Let's look at the report:

```
TIN vs Level Volume Totals
Volume unit: Cubic Meter
TIN File: C:\HYPACK 2017a\Projects\Generic Volumes\Sort\OGBOGU COR-
RECT DATA_Invert.xyz
Level          Volume above          Volume Below
-----
10.00          65938.3          15348.7
```

Wow! Now I have a Volume Above and Volume Below. What does it all mean?

We know (from our first example) that the **Volume Below** is our reservoir volume, so what is the Volume Above?

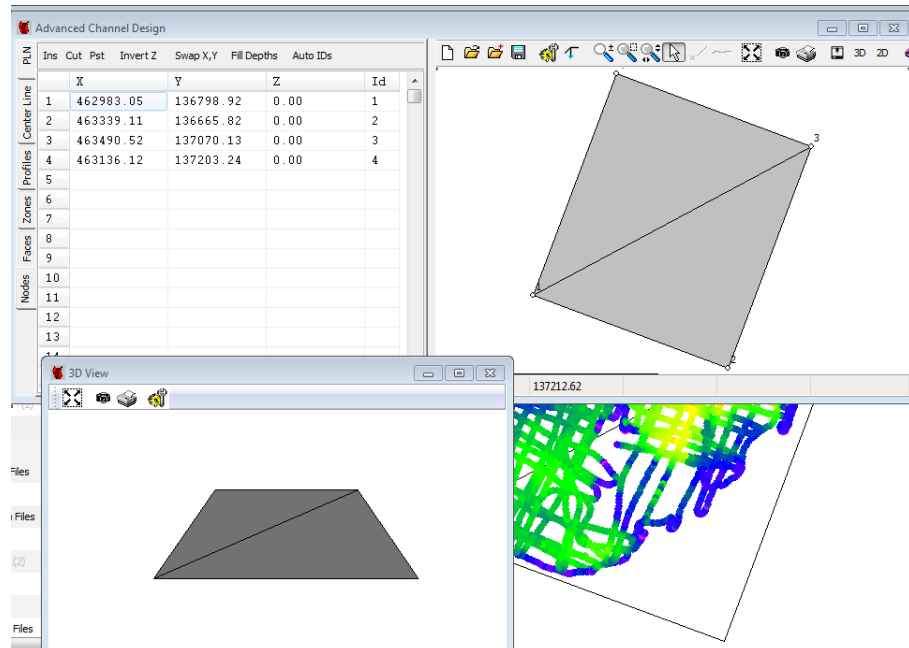
In Figure 6, the **Volume Above** is the volume of the grey material. If we wanted to excavate the grey material and bring the whole surface down to 10, that is the volume of material we would remove.

As you can see, TIN-to-Level is simply a cut/fill volume calculation!

Well this is all well and good right? We can take the volume verbatim and run with it? I always like to have a check against another method so that I can ensure that things not only are going the right way but that we check it against another method like TIN-to-CHN.

## VERIFYING YOUR CALCULATIONS

This example is easy. I made 2 CHN (channel design) files. One with 0 level and one with 10 level. I used ADVANCED CHANNEL DESIGN in this case.



Now let's compare the volumes for TIN-to-CHN and TIN-to-Level and give yourself a sanity check:

**FIGURE 7.** TIN-to-CHN where the CHN defines Level = 0.

```
TIN vs Level Volume Totals
Volume unit: Cubic Meter
TIN File: C:\HYPACK 2017a\Projects\Generic Volumes\Sort\OGBOGU CORRECT DATA_Invert.xyz

Level      Volume Above      Volume Below
-----
0.00              0.0      1173013.4

TIN vs Channel Volume Totals - Itemized by Channel Faces
Volume unit: Cubic Meter
TIN File: C:\HYPACK 2017a\Projects\Generic Volumes\Sort\OGBOGU CORRECT DATA_Invert.xyz
CHN File: C:\HYPACK 2017a\Projects\Generic Volumes\0.chn
*****

Face      Design Cut Volume      Design Fill Volume
-----
1              0.0      494997.1
2              0.0      678016.3
-----
Total]              0.0      1173013.4
```

As we can see in this volume report that the Volume Below in TIN-to-Level and the Fill for TIN-to-CHN are the same number!

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Now lets look at the 10 level and see how they compare:

**FIGURE 8.** TIN-to-CHN where the CHN defines Level = 10.

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|                                                                                        |                         |                          |
|----------------------------------------------------------------------------------------|-------------------------|--------------------------|
| TIN vs Level Volume Totals                                                             |                         |                          |
| Volume unit: Cubic Meter                                                               |                         |                          |
| TIN File: C:\HYPACK 2017a\Projects\Generic Volumes\Sort\OGBOGU CORRECT DATA_Invert.xyz |                         |                          |
| Level                                                                                  | Volume Above            | Volume Below             |
| -----                                                                                  |                         |                          |
| 10.00                                                                                  | 65938.3                 | 15348.7                  |
| =====                                                                                  |                         |                          |
| TIN vs Channel volume Totals - Itemized by Channel Faces                               |                         |                          |
| Volume unit: Cubic Meter                                                               |                         |                          |
| TIN File: C:\HYPACK 2017a\Projects\Generic Volumes\Sort\OGBOGU CORRECT DATA_Invert.xyz |                         |                          |
| CHN File: C:\HYPACK 2017a\Projects\Generic Volumes\10.chn                              |                         |                          |
| *****                                                                                  |                         |                          |
| Face                                                                                   | Design<br>Cut<br>Volume | Design<br>Fill<br>Volume |
| -----                                                                                  |                         |                          |
| 1                                                                                      | 27931.3                 | 5695.4                   |
| 2                                                                                      | 38007.0                 | 9653.3                   |
| -----                                                                                  |                         |                          |
| Total                                                                                  | 65938.3                 | 15348.7                  |

We see the same thing here. TIN-to-Level and TIN-to-CHN match perfectly. TIN-to-Level is simply a cut/fill volume calculation!

This data has come from a customer that recently called into Support. I hope this document will help you all understand how this method works.

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**IMPORTANT:** There is *one caveat!* **If you are in Elevation Mode**, the Volume Below and the Volume Above get swapped! This is super important. I inverted this user's data to present this in the mode in which most people will use this method. Pay attention to this one detail and you will be doing volumes in record time and be able to see visually what the TIN model is producing for your volumes.

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