

# Horizontal XSection Manual

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# Contents

Chapter 1 - Overview .....	6
Survey Data – The Heart of the Program.....	6
Quick Reference (The Different Program Modes) .....	7
Lithology Mode (Cross-Section Track):.....	7
Text Mode (Cross-Section Track, Graph Tracks):.....	7
Draw Line Mode (Cross-Section Track):.....	7
Add Image Mode (Cross-Section Track):.....	7
TVD Log Mode (Cross-Section Track).....	8
Geo-horizon Mode (Cross-Section Track).....	8
Save .....	8
The ToolBar Buttons .....	8
Chapter 2 - Getting Started.....	9
Entering Survey Data.....	9
Editing Lateral Curve Attributes.....	10
Lithology Mode and Drawing Lithology Beds .....	10
Text Mode and Adding Text to your Log.....	11
Adding Formatted Surveys as Text to your Log .....	12
How to Quickly Change Text parameters (Fonts, Font Size, Font Color and Font Background Color).....	13
Adding Text to the Sample % Track .....	13
Draw Line Mode and Adding a Line to your Log.....	13
Calculating Apparent Dip Using the Draw Line Feature.....	14
Add Image Mode and Adding Images to your Log.....	15
TVD Log Mode.....	15
Zooming .....	15
Chapter 3 - The File and Formatting Menus .....	16
The File Menu .....	16
Open and New .....	16
Cover Page .....	16
Auto Save Features .....	17
Automatic Backup File Feature .....	17
Automatic Save Feature.....	18
Page Setup and Printing.....	18
Export Log as Image (JPEG, TIFF, BMP.....)	18
Export Curve Data as LAS File (*.las).....	18
The Format Menu .....	19
Log Formatting.....	19

Formatting Menus.....	19
Histogram Format Menu.....	19
Histogram Name .....	19
Value versus Factor Mode .....	19
Which Way is Up .....	20
The Graph Tracks .....	20
Formatting the Cross-Section TVD Scales .....	20
.....	21
The Effects of Adding a New TVD Scale .....	21
Format Lateral Curve Attributes .....	22
Chapter 4 - Graph Data (ROP, Total Gas, Gamma, etc...)	23
The Graph Editor.....	23
Editing Curve Data.....	23
Import Graph Data.....	24
Overwriting Data.....	25
All Depths / Some Depths .....	25
Out-Of-Order-Depths.....	26
Linear or Semi-Log Scales.....	26
Export Files.....	26
Chapter 5 - Survey Data .....	27
Glossary of Terms and abbreviations: .....	27
The Tie-In Value .....	27
Adding, Editing and Deleting Survey Data .....	28
Importing and Exporting Survey Data.....	29
Matching the Directional Drillers Values .....	30
Chapter 6 - Lithology Patterns and the Lithology Mode.....	31
Introduction .....	31
Creating Custom Patterns with Microsoft Paint .....	31
Importing Lithology Patterns .....	31
The Lithology Library.....	32
Lithology Mode .....	32
Delete, Move, Rotate and Resize Lithology Elements .....	33
Rotate.....	34
Selecting a Rotated Bed .....	35
Copy and Paste.....	35
Group Lithology Beds.....	35
Creating a Fault .....	35

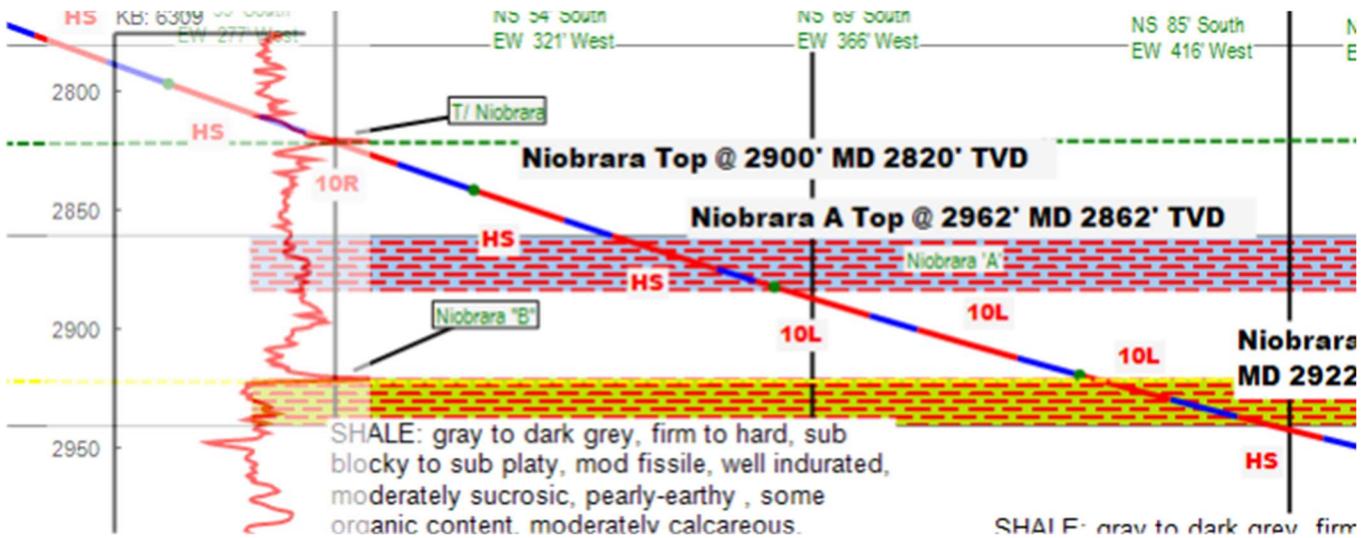
Chapter 7 - Log Images and Photos .....	37
Log Mode .....	37
Pointer Line Attached to Photo's or Log Images.....	37
Adding / Removing Images to the Add Image Dropdown Menu.....	38
Creating Bitmaps.....	39
Bitmap Library (Log Images - XSection Utility Folder).....	39
Importing Photos and the "Set Max Dimension" .....	39
Append Photo (or any Image), and Text to any "Log Image" or Photo Thumbnail .....	40
Log Size.....	42
Chapter 8 - Printing .....	43
Page Setup .....	43
Scale to Page .....	43
Printing.....	44
Print Preview - creating a PDF file.....	44
Continuous (Banner) Printers .....	44
Chapter 9 - Sample Track, Histogram Track and the Tools and Views Menu.....	45
Adding Samples Data to the Sample Track .....	45
Improved Histogram Track.....	46
Values mode.....	46
Factor mode .....	46
Adding Histogram Data to the Histogram Track.....	47
Tools Menu .....	47
Set Sample Interval .....	48
Set Default Text Styles .....	48
Delete.....	48
Clean-Up Log Utility .....	48
Dip Calculator.....	49
Subsea .....	49
Geo-Steering Correlation Tool .....	50
Expand Toolbar Lithology Images Menu Item .....	50
Calculate Kick-Off Point Calculator .....	50
Views Menu .....	51
Plan or Map View.....	51
Chapter 10 - TVD Logs.....	53
TVD Logs.....	53
Loading a Log .....	53
Deleting a Log.....	54

Editing a Log .....	55
Adding a Log to the Cross-Section .....	55
Setting Log Opacity .....	55
Log Subsea .....	56
Missing TVD Logs.....	56
Chapter 11 - Geo-Horizons in the Cross-Section.....	58
Geo-Horizons - Tops, Faults and other 2-dimesional Surfaces .....	58
Geo-horizon Editor.....	58
Geo-horizon Data.....	58
Adding Geo-horizon Data to the Mudlog.....	59
Edit Feature.....	60
Chapter 12 - Geosteering Tool.....	61
Introduction .....	61
TVD Logs and the TVD Log Tab .....	63
Color-Coding .....	63
Target Top and Bottom.....	63
Adding Other Tops .....	64
Reference Depth Offset .....	64
Zooming .....	64
Lateral Tab.....	64
LWD Tab.....	65
Dips Tab.....	67
Colors Tab .....	67
Lateral Length Menu Item.....	68
Tools Menu Item.....	69
Create Geohorizons Tool.....	69

The Horizontal XSection software was created, designed, and coded by a well-site geologist<sup>i</sup>, for geologists, engineers and technicians who are looking for more comprehensive software on their horizontal projects. This manual has been updated in 2016 to reflect a new improved geosteering tool.

## Survey Data – The Heart of the Program

The most important visual component of the Horizontal XSection is the Cross-Section track, which is organized around the survey data. Horizontal XSection utilizes the "Minimum Curvature Method" to calculate the True Vertical Depth, as well as the other derived survey information (Vertical Section, NS or Northings, EW or Eastings, Doglegs - see "Chapter 5 - Survey Data" for more information). Moreover, the software interpolates the borehole azimuth and inclination for every foot between surveys, and calculates the related survey parameters (TVD, VS, Northings, etc.). The below figure shows a portion of a log showing the "build" section of a horizontal well; the red sections are slides while the blue is when they were rotating. The green dots are the surveys.



Besides calculating the survey data parameters, the Horizontal XSection Log software allows for easy access to the survey data. The calculated survey values are stored in the programs memory and are constantly displayed relative to the position of the mouse pointer. For example, in the below example, the mouse is at 3742.0' MD and displays all the relevant survey data in the status bar at the bottom of the window. If there are two or more laterals displayed at the same measured depth, for example, a well plan or a sidetrack, the software will determine which curve is closer to the mouse pointer, and display only that lateral's survey information. If you move the mouse directly over a survey point, the annotation in the status bar will indicate that this is a survey point. When there is no mention of a survey point (as in the below example), the status bar displays calculated (interpolated) survey parameters for measured depths that occur between survey points.

The other tracks consist of four graphs for the ROP, TG and or GC data, Gamma or other LWD data, a sample track to hold the sample components, and three histogram tracks that can be used for a variety of purposes like porosity, flare length, show quality, grain size, cleating, or any information that is best displayed by a histogram. Most of the editing of the log will occur in the cross-section track. The log is formatted using the formatting menus. Use the histogram tracks



### TVD Log Mode (Cross-Section Track)

The "TVD Log" mode is used to enter, move, change the opacity, and change the depths from TVD to Subsea, of logs in the cross-section track. There must be at least one TVD Log loaded into the TVD Menu for the user to enter "TVD Log" mode.

Move the mouse over a log image (orange bounding rectangle will appear) and right-click for the editing menu.

See "Chapter 10 - TVD Logs in the Cross-Section", for more information.

### Geo-horizon Mode (Cross-Section Track)

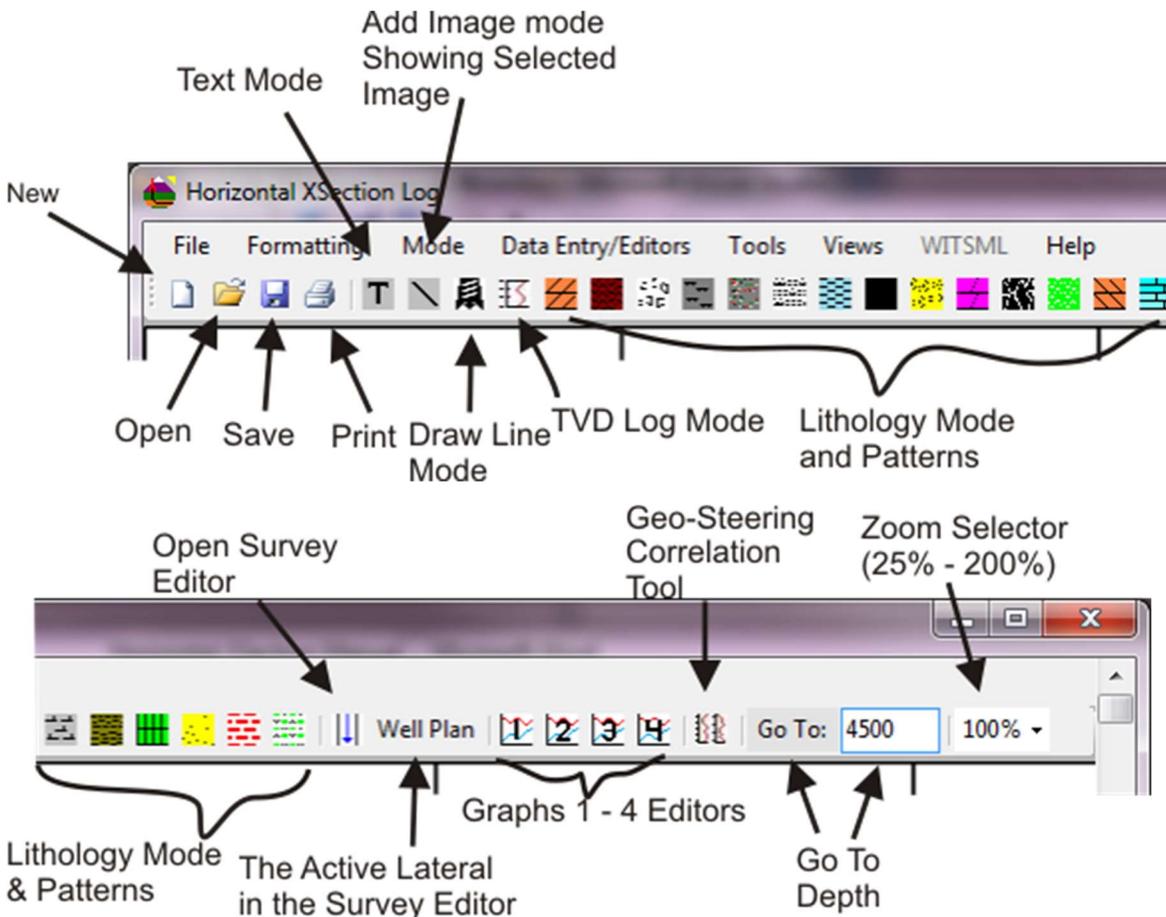
Use this mode to draw geologic features onto the cross-section that can then be projected onto the "TVD vs. Vertical Section" View (See Chapter 11, which is about the Geo-horizon feature).

### Save

Save often and backup files regularly and/or enable the AutoSave function. More on saving and backing up logs in the "Chapter 3 - The Formatting and File Menu".

### The ToolBar Buttons

The toolbar allows for quick access to many of the features described in subsequent chapters. The below illustration explains what the different buttons on the toolbar do.

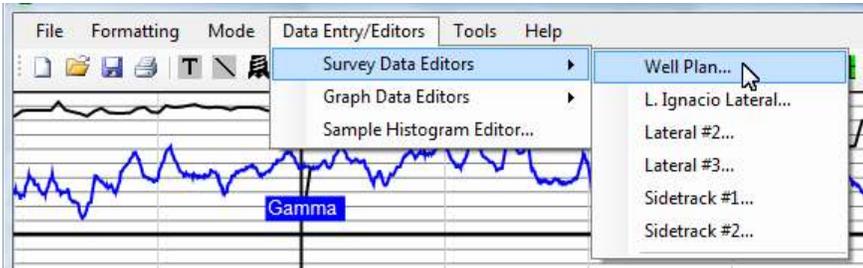


## Entering Survey Data

The heart of this program is the survey data and the ability for this program to compute the derived survey parameters.

Start the XSection Horizontal Log Program.

Begin by clicking on the menu bar item Data Entry/Editors ->Survey Data Editors->Well Plan....



This will open up the Survey Data Sheet for the Well Plan curve.

Well Plan Survey Data Sheet

MD	INC	AZ	TVD	VS	NS	EW	DLS
1000	0	180	1000	0	0	0	0

Edit/Add Tie-In Survey      Direction (vertical section along azimuth): 180

MD	INC	AZ	TVD	VS	NS	EW	Dogleg / 100'
1350	89.5	180	1224.05	222.1	-222.11	0.00	25.57
2000	89.5	180	1229.73	872.1	-872.08	0.00	0.00

**Slide Report**

Add Slide Interval      Slide From:   
Slide To:   
Tool Face (optional) HS

Delete Slide

Start	End	Tool Face
1000	1350	HS

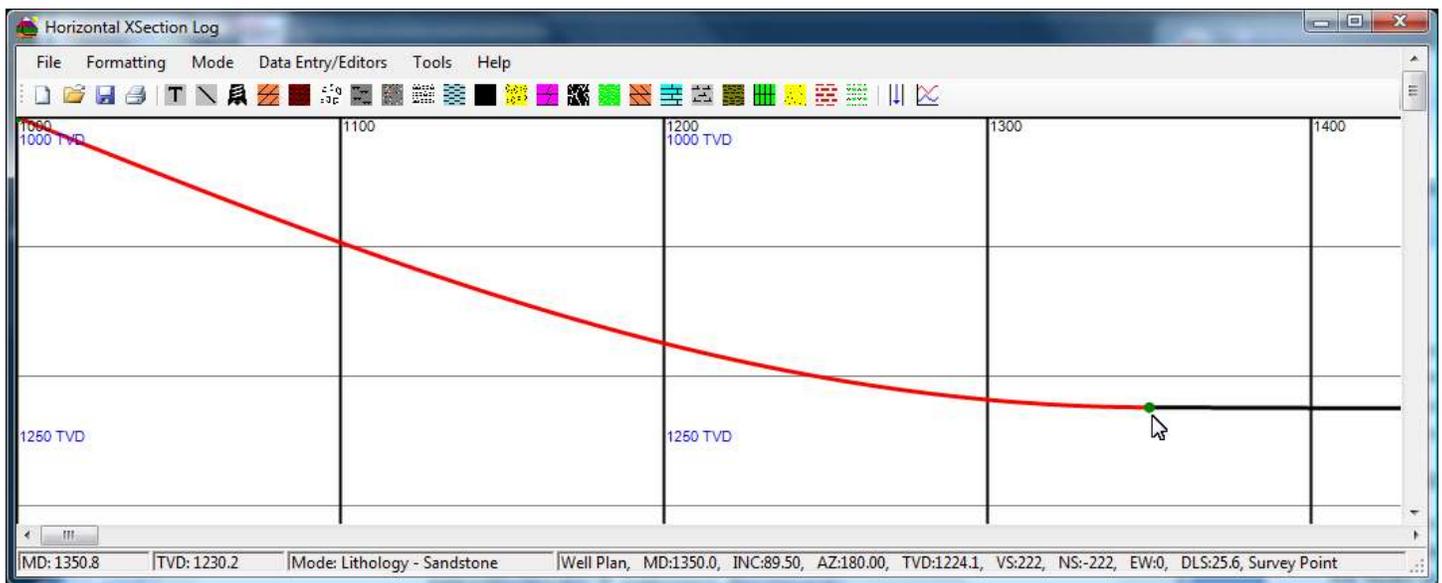
Add Survey      Import Surveys (\*.csv)      Export Surveys (\*.csv)      Done

Delete Survey      Import Slides (\*.csv)      Export Slides (\*.csv)

Select the "Edit/Add Tie-In Survey" button and enter "1000" in the "MD" field, "180" in the "AZ" field and "1000" in the "TVD" field, leave everything else as zeros and make sure the "Direction" field is set to "180" (see above).

Note: when entering Tie-in Values, all the fields must be filled. If the Tie-In value is an existing survey, you enter all the fields in the tie-in value window from the tie-in survey. In order for the program to accurately calculate the vertical section (VS), the "Direction" field must be correctly set (the Directional Driller will have this information). See "Chapter 5 - Survey Data", for more information regarding the derived survey data. After the tie-in value are entered for a particular lateral, only the MD, AZ and INC need be entered, the Horizontal XSection Log software will calculate the other survey fields .

Now click on the Add Survey button and enter "1350" for Measured Depth (MD), "89.5" for Inclination (INC) and "180" for azimuth (AZ), and click the "Done" button. Click "Add Survey" again and enter "2000" (MD), "89.5" (INC) and "180" (AZ) and click the "Done" button. Now go to the right side of the editor and type "1000" in the "Slide From" text box and "1350" in the "Slide To" text box and click the "Add Slide Interval" button. Now click the "Done" button to exit the Well Plan Survey Data Sheet window. The Horizontal XSection program will draw a well plan curve that goes from vertical to horizontal with 25.57 degree doglegs. Green markers are shown at



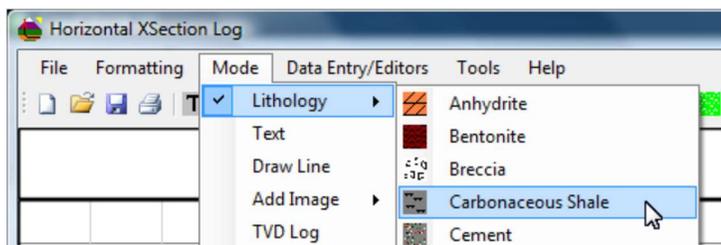
the survey points. The line is red during sliding intervals, and black during rotating intervals. Notice the survey data shown on the status bar at the bottom of the window as you move the mouse along the planned well curve. At survey points, the survey data and parameters will be annotated with the words "Survey Point", as in the example above. Between the survey points the survey data is interpolated and there is no "Survey Point" annotation.

### Editing Lateral Curve Attributes

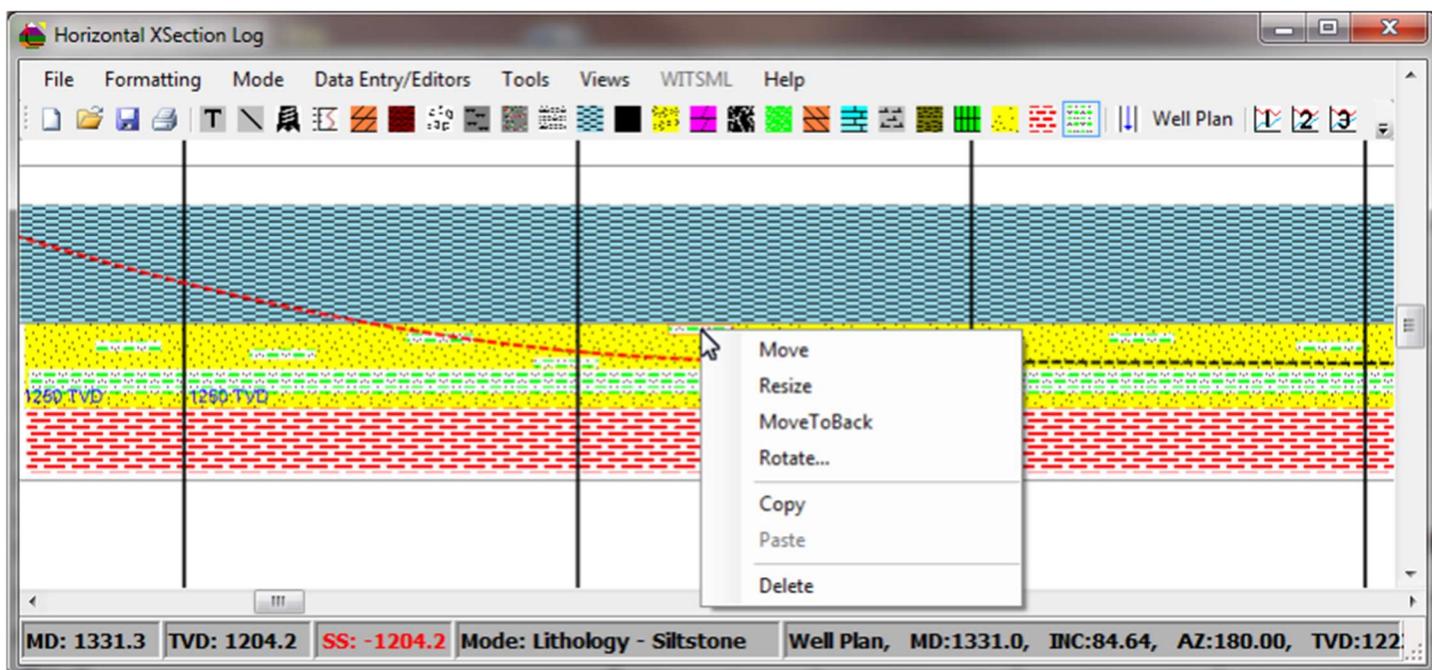
Click the menu item Formatting->Format Lateral Curve Attributes..., to open the "Edit Lateral Line Attributes" window. Select the "Well Plan" lateral from the list on the right side of the window, and all the attributes for this curve will appear in the "Styles" section. Change the line style from "Solid" to "Dash", and make any other changes to the style of the well plan curve. Notice you can even change the name of the lateral, for example type in Well Plan #1, and click change name. This will change the name of the lateral on the logs legend when the log is printed, as well as in the Survey Data Editor menu, the plan view and on the TVD versus Vertical Section view (see later chapters). Click "Done" when you are finished making changes.

### Lithology Mode and Drawing Lithology Beds

There are six modes for editing your log: "Lithology" mode, "Text" mode, "Draw Line" mode, "Add Image" mode, "TVD Log" mode and "Geo-Horizon" mode.



For the lithology mode, simply click the menu item Mode->Lithology-> and select any of the 20 Lithology patterns, alternately, select a lithology from the toolbar. The cursor will change to a cross. Left click and hold, move the mouse to draw your bed, release the mouse when done drawing. To add a stringer to your log, just click once without moving the mouse, and a stringer will appear at the click point. Use the menu item Mode->Lithology->Set Stringer Size... to change the default stringer dimensions.

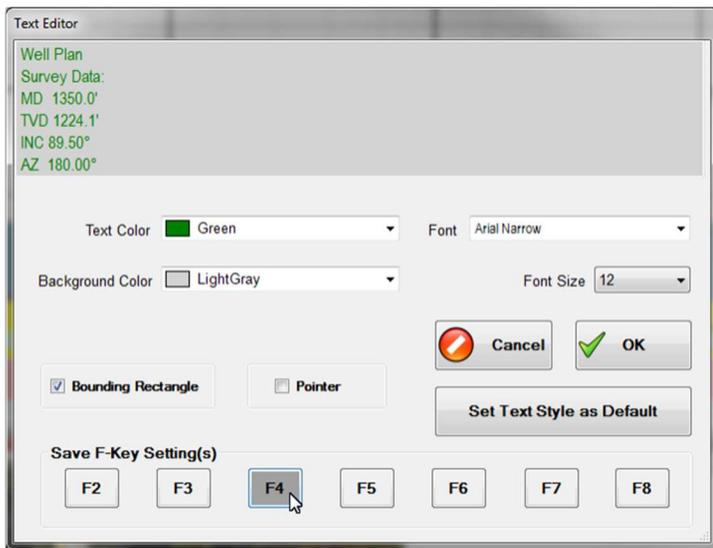


An orange border will appear when the mouse cross hovers over a particular lithology element (bed or stringer). When you see the orange border, right click to "Move", "Delete", "MoveToBack", "Rotate" or "Copy" the selected element. A delete lithology bed shortcut is to left click a bed while holding down the "Ctrl" key. Similarly, hold down the "shift" key while left-clicking a lithology bed to move the selected lithology bed to the back (MoveToBack function).

### Text Mode and Adding Text to your Log

Text can be added to the cross-section track, the graph tracks and the sample % track.

Click the menu item Mode->Text, or select the Text Symbol **T** from the toolbar. Click on the log where you want to add text and a Text Editor window will appear. The text editor window is very simple and self-explanatory. To select text that is already on the log, just click on the selected text in Text Mode, and the text editor will appear with the selected text loaded into the Text Editor.

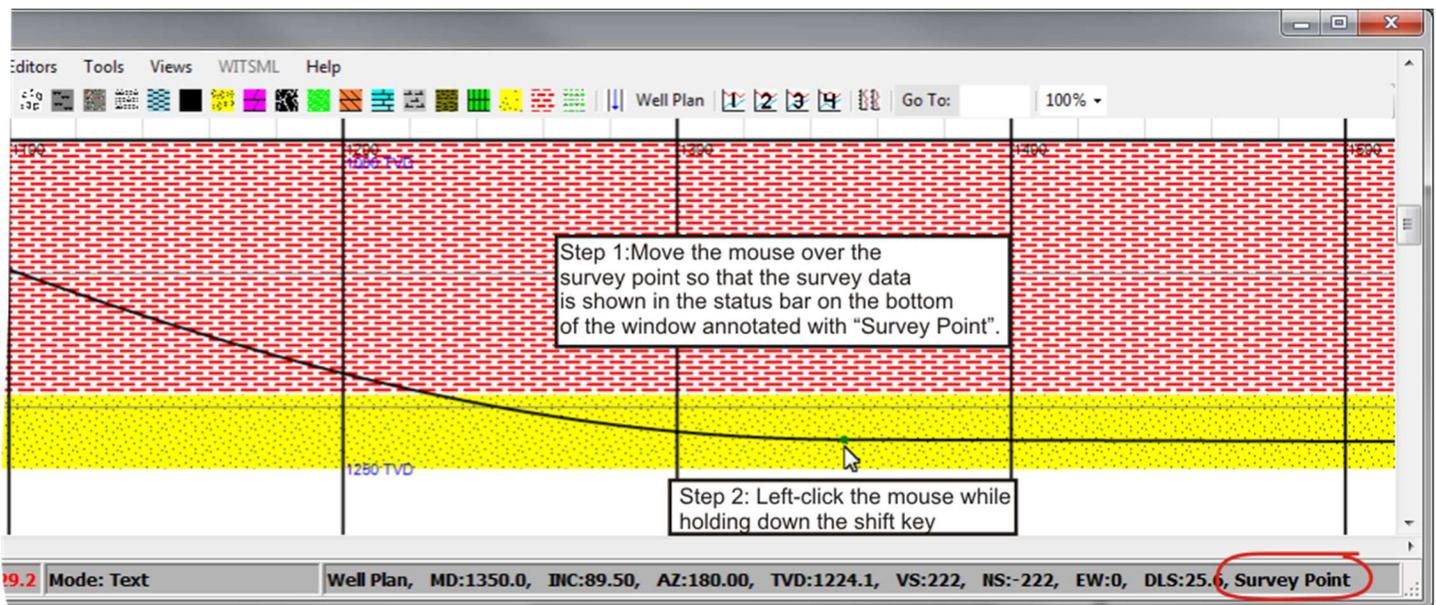


By depressing the F4 button in the "Text Editor" as show to the left, the selected font (Arial Narrow), font size (12), background color (light gray), and font color (green), will be saved to the F4 key. Now whenever the text editor is opened, depressing the F4 key on the keyboard will load Arial narrow, font size 12, background color light gray and font color green on the keyboard.

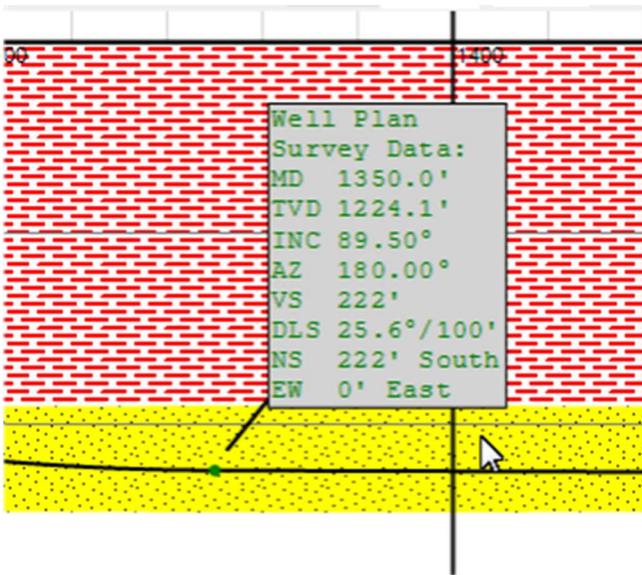
When in "Text" mode, an orange border will appear when the mouse arrow moves over a text element, or within 10 pixels (about a 10<sup>th</sup> of an inch) of the end of a pointer line associated with a text element. Right click to "Move" "Resize" or "Delete" a text element. A pointer line can only be moved. Open the text editor to deselect the pointer or bounding rectangle check boxes to make them disappear.

### Adding Formatted Surveys as Text to your Log

To add formatted survey data to your log, while in "Text Mode" move the cursor to the desired point on the lateral, **hold down the shift key and left-click the mouse**. This will load the survey data that is in the status bar at the bottom of the window into the Text Editor.



To make the survey data easier to read for the viewer, choose a monospaced font, for example "Courier New".



**Note, if a client computer does not have the font that you selected, a default font will be substituted - usually this font will be "Microsoft Sans Serif". This may result in a log that looks different on your client's computer than on your computer. One way to avoid this problem is to select common fonts like Arial, Times New Roman, Courier New and Consolas.**

#### How to Quickly Change Text parameters (Fonts, Font Size, Font Color and Font Background Color)

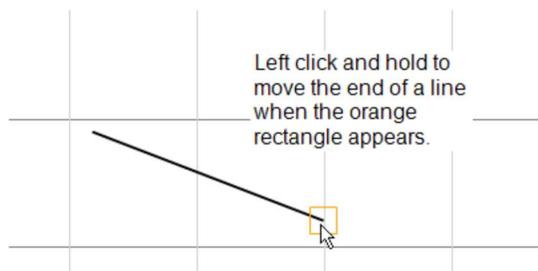
For organizational purposes, it is a good idea to use the same text parameters (font, font size, font color and background color) for text added for similar purposes. For example use one set of text parameters for sample descriptions, another for drilling parameters. A recent change to the text editor now allows the geologist / user to preset the F2 through F8 Keys to any text style (font type, font size, font color and background color). With the text editor open the user can depress any of the F2 through F8 to load the preset text style. Use the "Set F Keys" buttons to set F2 – F8 to the loaded font style. F key preset styles are saved to the laptop, so that any new font style set to any F key is remembered by the program between user sessions.

#### Adding Text to the Sample % Track

Because left-mouse clicking on the sample % track opens the sample % editor, even in text mode, adding text to this track is slightly different than to the other tracks. To add or edit text in the Sample % track, the program must be in "Text" Mode and the user **must have the Control (Ctrl) key depressed when depressing the left mouse key! The Control (Ctrl) key must also be depressed to move, resize or delete text blocks in the Sample % track!**

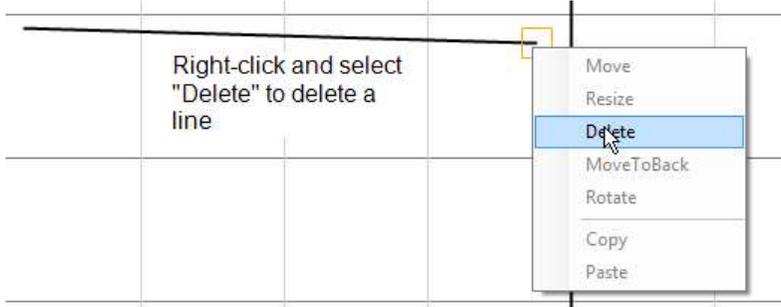
#### Draw Line Mode and Adding a Line to your Log

Click the menu item Mode->Add Image, or click the  icon on the toolbar. Click and hold the left-button on the mouse to start drawing your line. Release the left mouse button when done drawing. To move a line, position the mouse arrow over either end of the line until the small orange rectangle appears. Then left click and hold while moving the mouse.



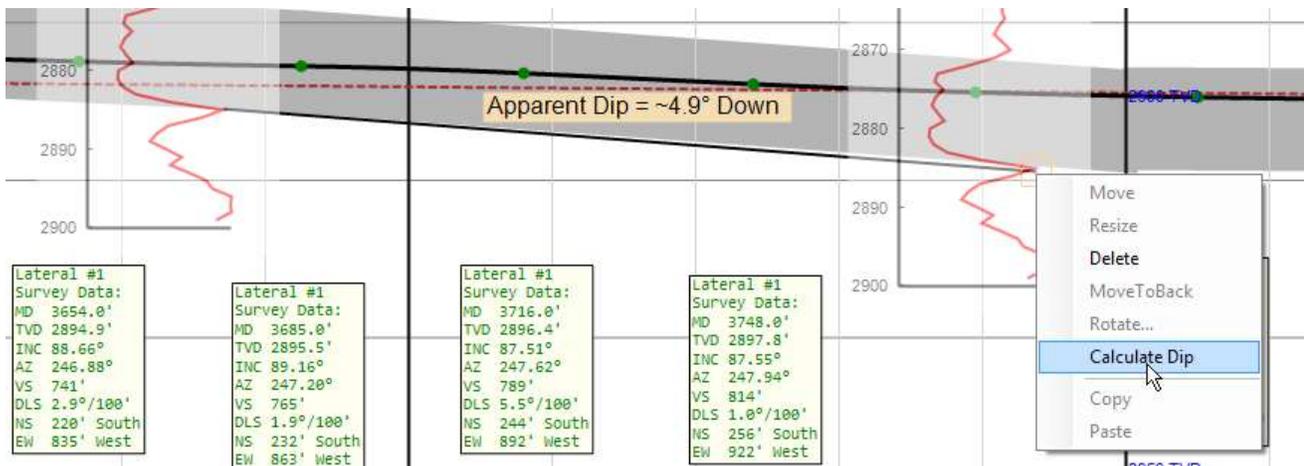
Release the left-mouse button when finished repositioning the line. To delete a line, first position the mouse over either end of a line until the orange rectangle appears. Then right-click the mouse and select "Delete". Another method of deleting a line is simply to **resize the line to less than 1/2 inch.**

**Note, the steps for drawing and moving a line in "Draw Line" mode are different than the steps for moving a pointer line connected to a text block in "Text" Mode.**



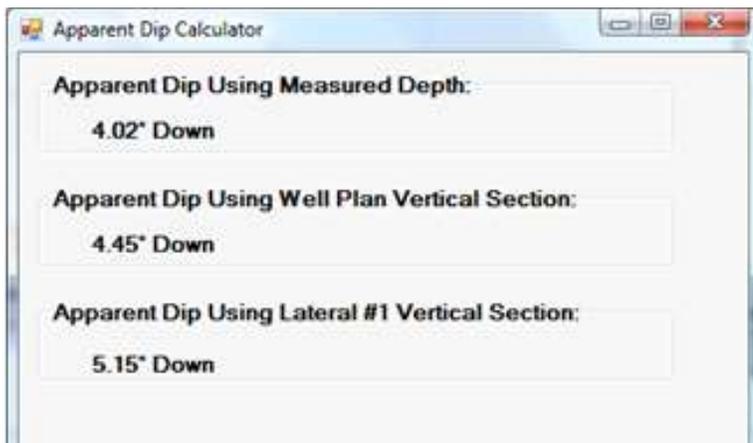
### Calculating Apparent Dip Using the Draw Line Feature

The "Draw Line" mode of the Horizontal XSection has a "Calculate Dip" tool that will calculate the apparent dip of the line based on the change in TVD of the line and the distance between the beginning of the line and the end of the line. To access this feature, simply draw a line where you want to measure the dip. Then right-click the mouse over either end of the line and select the "Calculate Dip" from the popup menu as show below. Note: the line in question is drawn between the bottom of the coal seam connecting the two TVD Logs.



The apparent dip calculator will calculate a value based on the difference in measured depth and TVD (or SS) for the line that was drawn. However, this could be an inaccurate value for a borehole trajectory that is not near 90° Inclination, or is turning. The program will also project the apparent dip using the vertical section values for any laterals that are present for the whole length of the drawn line. In the above example, the apparent dip is calculated using the measured depth of the line as well as the vertical section for similar depths for the "Well Plan" and "Lateral #1". Surprisingly, the values diverge by over 1°.

The apparent dip calculator will calculate a value based on the difference in measured depth and TVD (or SS) for the line that was drawn. However, this could be an inaccurate value for a borehole trajectory that is not near 90° Inclination, or is turning. The program will also project the apparent dip using the vertical section values for any laterals that are present for the whole length of the drawn line. In the above example, the apparent dip is calculated using the measured depth of the line as well as the vertical section for similar depths for the "Well Plan" and "Lateral #1". Surprisingly, the values diverge by over 1°.



Or, use the "Dip Calculator" in the tools menu as an alternate method to determine an apparent dip.

### Add Image Mode and Adding Images to your Log

Click the menu item Mode->Add Image->select any of the images in the list, or click the  icon on the toolbar. The toolbar holds the last image selected from the Add Image menu. Left click anywhere on the cross-section track to add your image. Right click over

the image to delete or move the image. There is more on images in "Chapter 7 - Log Images and Photos".

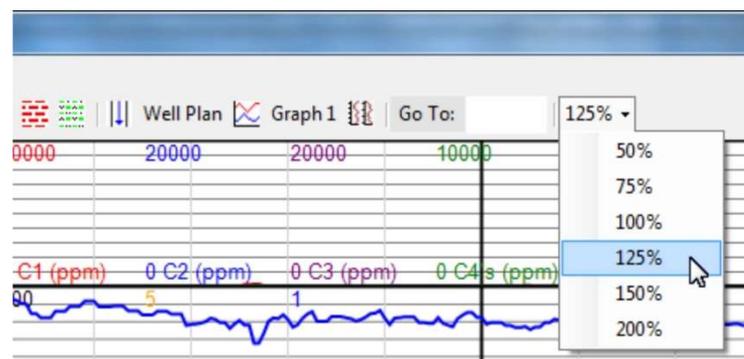
### TVD Log Mode

The TVD Log mode is used for adding Log curves to the cross-section track. These logs can be from pilot hole wire-line logs, TVD logs generated while drilling the curve, or offset logs from nearby wells, and is an essential tool in geo-steering your horizontal well.

Click the menu item Mode->TVD Log ->select any of the logs in the list, or click the  icon on the toolbar. If there are no logs loaded in the menu item, the user will not be able to select "TVD Log" mode. This is true, even if there are log images on the cross-section.

Much more can be learned in Chapter 10 - "TVD Logs in the Cross-Section".

**Note: occasionally when a log file is first opened by double clicking on a file, the TVD logs will be missing from the list in the TVD Log menu. Open and close the "Cross-Section TVD Log Editor" (Data Entry/Editors->Cross-Section TVD Log Editor... menu) to list the TVD logs.**



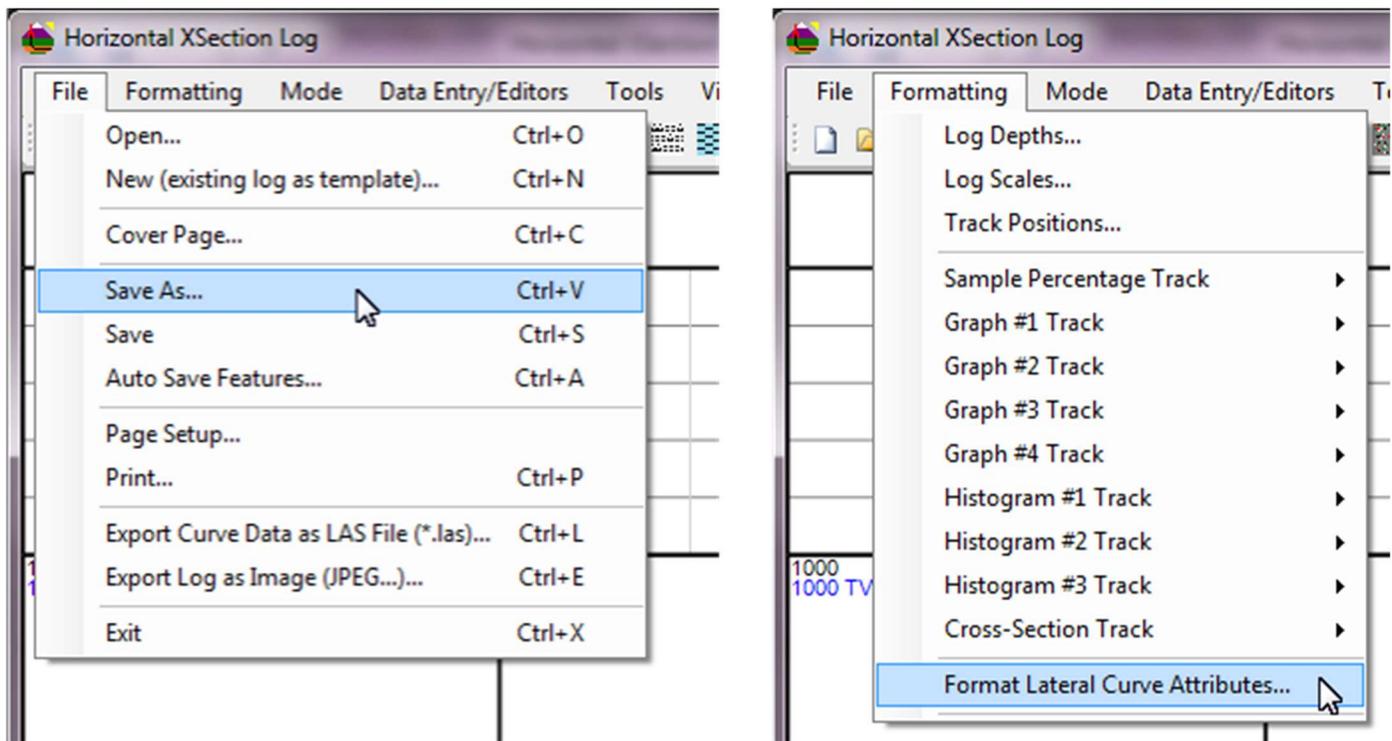
### Zooming

The graphic on the left shows the location of a drop down menu on the far right of the toolbar. Simply select the degree of magnification that you desire and the log will automatically scale and redraw. The default magnification is 100%. Note however, that all elements will automatically move and be scaled to the new magnification, with the exception of Log Images and Photos that are added to the log. Because of issues with pixilation, there is no scaling of photos or Log Images.

For example, a two- inch square photo added to the log remains 2-inch square regardless of the degree of zooming. However, pointer lines attached to a log image or photo will be scaled and shifted correctly!

## Chapter 3 - The File and Formatting Menus

The "File" menu holds many of the menu items found in all windows programs. The "Format" menu allows the user to easily and quickly format their log in a variety of ways. The following chapter discusses some of these features.



### The File Menu

#### Open and New

The File->Open selection will open a saved file. Use the File->New (existing log as template)... option to begin a new file with the same file formatting as the file presently open.

#### Cover Page

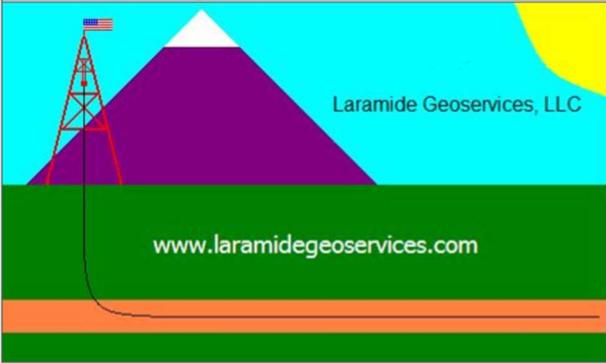
Select File->Cover Page... from the Menu Bar to open the Title Page Editor.

This editor is used to fill in the title or cover page header that begins every log (see below image) Click the "Import Header File" button to load a template cover page, or use the "Export Header File" button to save a template cover page. Drag and drop an image to the upper left-hand corner image box with your company logo or any image file (JPEG, TIFF, BITMAP, PNG, GIF, etc...) that you desire. Images that are larger than 5" x 3" will automatically be resized to fit, and print in the upper left-hand corner of the title page.

Click on the "Notes" button to open the edit notes window. This is the lower right-hand corner area (red circle) of the title page, and is a blank area that can be used for many purposes. For example casing data, or mud data or a short well synopsis can be entered in this area (see below).

**Title Page Editor**

Logging / Consultant Company and Personnel Information



**Well Information**

**Well Name:** Southerm Ute 32-12 NB #2-1H  
**Field:** Wildcat - Niobrara Member of the Mancos Shale  
**Region:** San Juan Basin  
**Coordinates:** 37.04915°, -108.12668°  
**Location:** SWNW Sec. 2, T32N 12W - 1752' FNL, 523' FWL  
**State / County:** La Plata, CO  
**API Index:** 05-067-09872-00  
**Rig Operator:** Key #887  
**Rig Supervisor:** Bruce Patterson & Dee Giles / David Wood  
**Directional Company:** Pathfinder

**Ground Elevation:** 6297.0      **K. B. Elevation:** 6317.0  
**Spud Date:** 2/10/2012  
**Drilling Completed Date:** 3/08/2012

**Company / Operator Information**

**Company:** Red Willow  
**Company Address:** PO Box 369, Ignacio, CO 81137  
**Company Geologist(s):** Jason Hooten, Rebecca Helms

**Geologists:** Peter Falk, Kyle Welty and David Stich  
**Company:** Laramide GeoServices, LLC  
**Company Address:** PO Box 20658, Albuquerque, NM 87154

Buttons: Clear, Drag and drop logo, use clear to delete, Import Header File (\*.hdf), Export Header File (\*.hdf), Done, Notes

### Notes Editor

**Edit Notes**

**Title:** Well Synopsis

**Main Text:**

The Four Paws Resources' Husky #1 consist of a single lateral targeting the Lower Ignacio Coal seam. the well was drilled as a J-hook lateral in November of 2009. The main purpose of this lateral was to drill as much coal as possible, but also to keep doglegs to a minimum so as to run an EPC liner to TD.

The Fruitland Coal Seam tops came in as expected with the target Lower Ignacio Coal top at 3080' TVD. However, a 3' to 4' shale stringer was encountered in the middle of the Lower Ignacio Coal Seam. The decision was made to try to stay below this interbed. This was successful, and 1608' of target coal was drilled.

A second Lateral #2 targeting the Upper Ignacio Coal is planned for the future.

Done

### Cover Page

	<p><b>Well Information</b></p> <p>Field: Chihuahua Formation  Region: Pooodle Basin  Coordinates: Lat 37° 01' 31.935", Long 107° 27' 50.310"  Location: 458' FSL, 2156 FEL, Section 26 T34N, R14W  State: Colorado, La Plata County  API Index: 12-34567-89  Rig Operator: Husky Drilling Rig #1  Rig Supervisor: Mr. Harry Mutt  Directional Company: Labrador Drilling  Four Paws Resources Geologist: Spot</p> <p>Ground Elevation(ft): 6547.0      KB Elevation(ft): 6559.0  Spud Date: 11/17/2009  Drilling Concluded: 12/1/2009</p>
<p><b>Well-Site Geologists</b></p> <p>Chinle Falk and Yesa Falk  Furry Dog Mudlogging  12345 Perro St.  Vizsla, WY</p>	<p><b>Well Synopsis</b></p> <p>The Four Paws Resources' Husky #1 consist of a single lateral targeting the Lower Ignacio Coal seam. the well was drilled as a J-hook lateral in November of 2009. The main purpose of this lateral was to drill as much coal as possible, but also to keep doglegs to a minimum so as to run an EPC liner to TD.</p> <p>The Fruitland Coal Seam tops came in as expected with the target Lower Ignacio Coal top at 3080' TVD. However, a 3' to 4' shale stringer was encountered in the middle of the Lower Ignacio Coal Seam. The decision was made to try to stay below this interbed. This was successful, and 1608' of target coal was drilled.</p> <p>A second Lateral #2 targeting the Upper Ignacio Coal is planned for the future.</p>
<p><b>Well Name and Company</b></p> <p>Well Name: Husky #1  Four Paws Resources  98765 Rawhide Ave.  Lkestobark, MT 56534</p>	

### Auto Save Features

Select File->Auto Save Features... from the menu bar to open the "Automatic and Backup Saving Features" window.

**Automatic and Backup Saving Features**

Automatic Backup File Feature  
 Automatic Save Feature

Done

There are two features: Automatic Backup and Automatic Save.

#### Automatic Backup File Feature

By default, the "Automatic Backup File Feature" is enabled whenever you start a new Horizontal XSection session. The "Automatic Backup File Feature" will create a folder called "XSectionBackup" in the same folder that you are saving your Horizontal XSection Log file. The "XSectionBackup" folder will contain a backup version (\*.hxl) of the file that you

are working on. This file will be called "BACKUP + file name". For example, if you create a new XSection file called "Lateral1" and save it to "My Documents", the Horizontal XSection Log will create a folder called "XSectionBackup" in "My documents" and create a backup of your lateral1 file named "BACKUPLateral1".

Moreover, the backup file will be updated after changes are made to your file. If the program or the computer crashes, the backup file will be the most up-to-date file. If you remove either the "XSectionBackup" folder or the "BACKUP + filename" file, the Horizontal XSection program will create a new folder and/or file. This creates a handy way of backing up your files. The process is to move either the backup file or the XSectionBackup folder to a removable drive, and the Horizontal XSection software will create a new one in its place.

If you use one of the BACKUP files to recover a session, quickly rename the file and move its location. Otherwise XSection will create a new XSectionBackup folder in the old XSectionBackup folder with the name BACKUP + filename + Backup + filename. This can become confusing fast. The work around is to quickly rename the file in a new location as soon as you open the backup file.

### Automatic Save Feature

The Automatic Save Feature is slightly different. This option, by default, is **not enabled** when you begin a new XSection session. The Automatic Save Feature, when enabled, saves your file before you make new changes to your log. For example, if your file is named "lateral1" and located in the "my documents" folder, and you select the "Text" editing Mode after just entering lithology beds using the "Lithology" editing mode, XSection will save the "lateral1" file without the user being prompted.

The automatic save feature, when enabled, automatically saves your file whenever you:

- change editing Modes (i.e. select either Lithology, Text, Add Image, Draw Line, or TVD Log),
- open the Survey Editor for any lateral,
- open the Graph Editor for any graph tracks,
- open the Histogram editor for any of the histogram tracks
- open any of the formatting menu items,
- open the "Log Depths..." menu item,
- open the Log Scale..." menu item,
- open the Format Lateral Curve Attributes... menu item,
- open the "Track Positions..." menu item.

### Page Setup and Printing

These menu items are discussed in the Chapter on printing (Chapter 8)

### Export Log as Image (JPEG, TIFF, BMP....)

The "Export Log as Image (JPEG, TIFF, BMP....)" menu item allows the user to export a complete log (with title page and legend) as either a JPEG, TIFF, BITMAP, GIFF or PNG file. Each of these file types have their advantages, which are listed below, file sizes are for average logs:

JPEG - easily uploaded by photo processing software, ~ 2 MB file<sup>ii</sup>.

TIFF - common oil field file type, high quality graphics usually over 2 MB file<sup>iii</sup>.

BITMAP - A great way to fill up your hard drive (euphemism for very large files ~50 MB file<sup>iv</sup>).

GIFF - small files (usually under 1 MB file<sup>v</sup>), low quality, web browser friendly.

PNG - web browser friendly, high quality, ~2mb file<sup>vi</sup> - use this file format to send to your clients if file size is not an issue.

### Export Curve Data as LAS File (\*.las)...

The "Export Curve Data as LAS File (\*.las)..." menu item saves all the curve data in all the graphs as a LAS file. Presently, data is saved in LAS 2.0 file format.

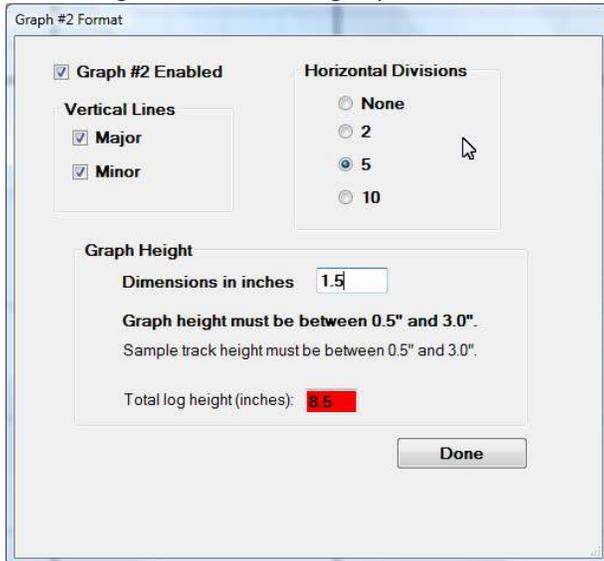
## The Format Menu

### Log Formatting

Click on Formatting->Log Depths..., Formatting->Log Scales..., or Formatting->Track Positions... to set the log depths, the log scales or the track positions, respectively.

### Formatting Menus

Each track has its own formatting window, and all follow a similar layout. For example, the below screen example is the format menu for "linear-type" Graph #2 (Formatting->Graph 2 Track->Formatting...). If the graph is set for semi-log, the formatting window looks slightly different.



The format window allows the user to enable or disable the track (except the cross-section track which cannot be disabled), set the vertical lines, set the horizontal divisions, and set the height dimension. The format window also keeps track of the total log height in inches, and turns red if the total height exceeds 8". This indicates that the total height is too large for landscape printing on 11" x 8.5" inch paper. Note the program will not stop the user from setting a height dimension that is over 8", rather the red is a warning to indicate possible printing problems.

### Histogram Format Menu

The Histogram Formatting menu has a few added features that differentiate it from the other format menus. These added features are a "Histogram Name" section, a "Scale" drop down menu, a "Divisions" drop down menu, a "Value Properties" section a "Which Way is Up" check box (see below example), and a "Factors" section.

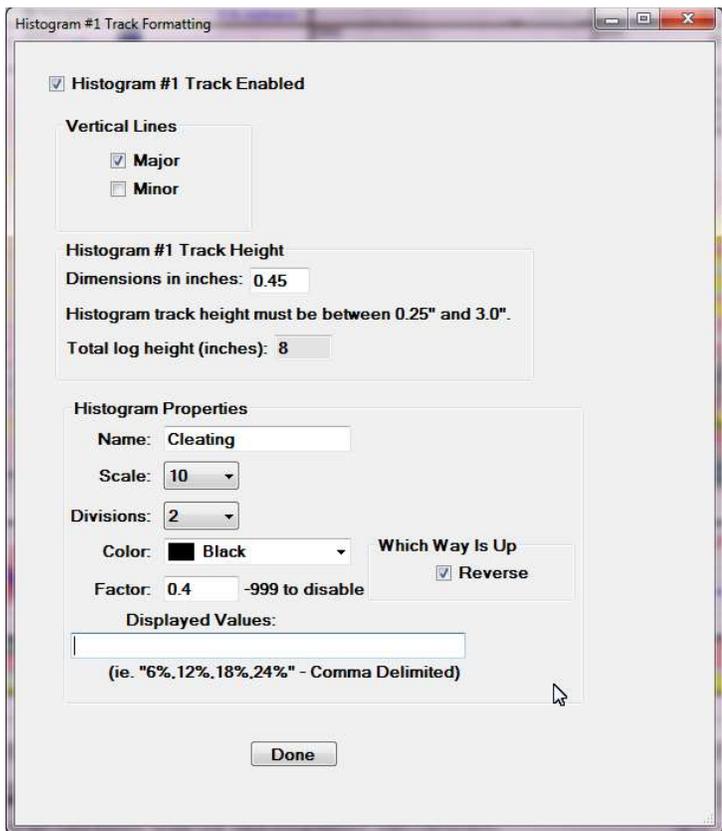
### Histogram Name

This section names the Histogram track. For example if you want the Histogram track to be used for porosity, type in "Porosity". Alternately, you could also use the histogram for cleating, grain size, rounding, flare length, directional driller ego size, etc. The name the user gives the histogram will be displayed on the histogram track when the log is printed.

### Value versus Factor Mode

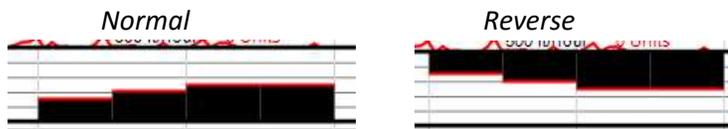
Simply, if the "Factor" text box is set to the value "-999", the histogram is in values mode and will have the values shown in the displayed values text box. Otherwise, the histogram will have a scale dependent on the "Scale" drop down menu value multiplied by the "Factor" value. In value mode, the scale drop-down menu is ignored, similarly, in factor mode, the "Displayed Values" values are ignored.

**Chapter 9 goes into more detail about the difference between value and factor mode and the histogram track in general.**



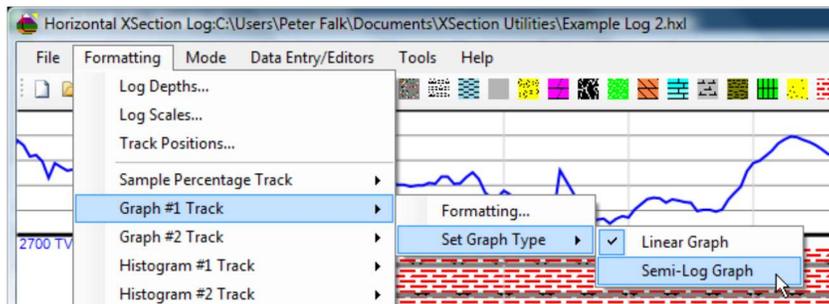
### Which Way is Up

This section of the histogram format window sets the direction the histogram will be drawn. Normal (the default setting) draws the histogram bottom to top. Check reverse and the program draws the histogram top to bottom.



### The Graph Tracks

The graph tracks also have the additional menu item that allows the user to select either a linear or semi-logarithmic format.



See "Chapter 4 - Graph Data" for more information on both linear and the semi-log formats and how to edit their corresponding scales using the "Graph Data Editors" under the "Data Entry/Editors" main-menu item.

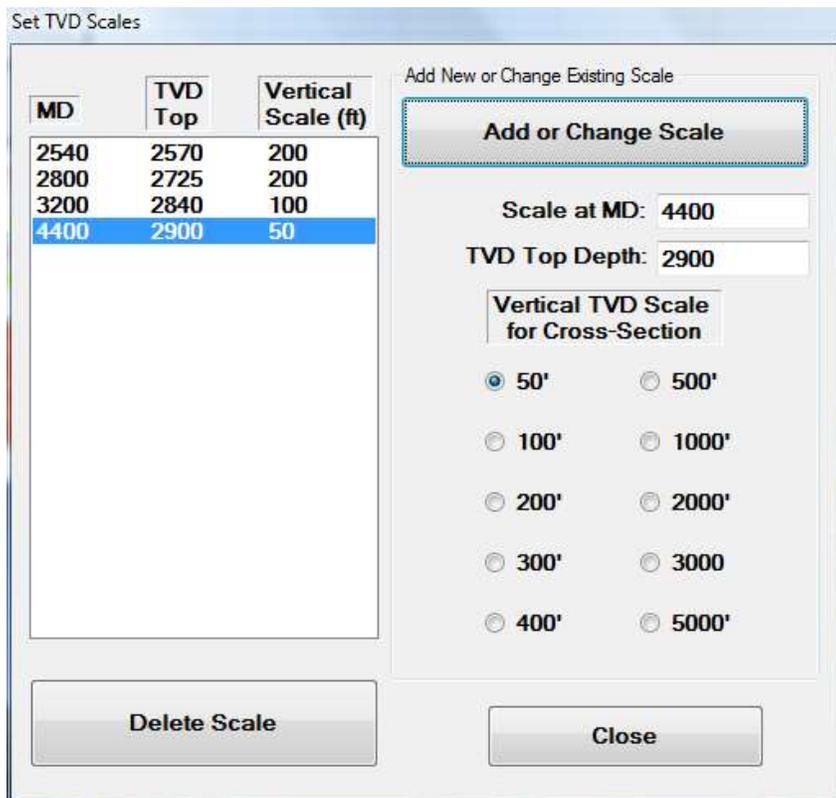
### Formatting the Cross-Section TVD Scales

From the menu bar, click Formatting->Cross-Section Track->Edit TVD Scales... to open the "Set TVD Scales" window. Each scale has three parts: The measured depth (MD) where the scale change begins, the TVD for the top of the scale, and the vertical TVD Scale.

These three parameters are set by the user. The vertical TVD scale is limited to the following selections: 50', 100', 200', 300', 400', 500', 1000', 2000', 3000', or 5000'. The TVD for the bottom of the scale is the TVD top + the vertical TVD scale. For example, the highlighted scale change, in the below example, shows a scale change occurring at 4400' MD, with the top of cross-section being at 2900' TVD and a 50' vertical TVD scale. Though it is not shown, this would put the bottom of the scale at 2950' TVD.

When you load the Horizontal XSection program, it begins with a default TVD scale of 500', set at 1000' MD with the TVD top scale set at 1000' TVD. There must always be at least one scale for the cross-section, and the first scale cannot be deleted. To change a scale, select the scale from the list of scales on the left, change the TVD Top Depth or the Vertical TVD Scale by choosing the appropriate radio button, and click the "Add or Change Scale" button. To create a new scale, type in a measured depth value in the text box labeled "Scale at MD" that does not exist in the list of scales. Then choose a TVD top value and a vertical scale value, and click the "Add or Change Scale" button. To delete a scale, simply select the scale from the list and click the "Delete" button.

Tip: Do not set a new scale right before or right after a 100' interval (i.e. 2195' MD or 2205' MD), this will result in overlap between the new scale text and the MD text values that occur every 100'. It is fine to set a new scale at a 100' interval (i.e. 2100' MD). Other safe values are to set the scale at 50' (i.e. 2150' MD).

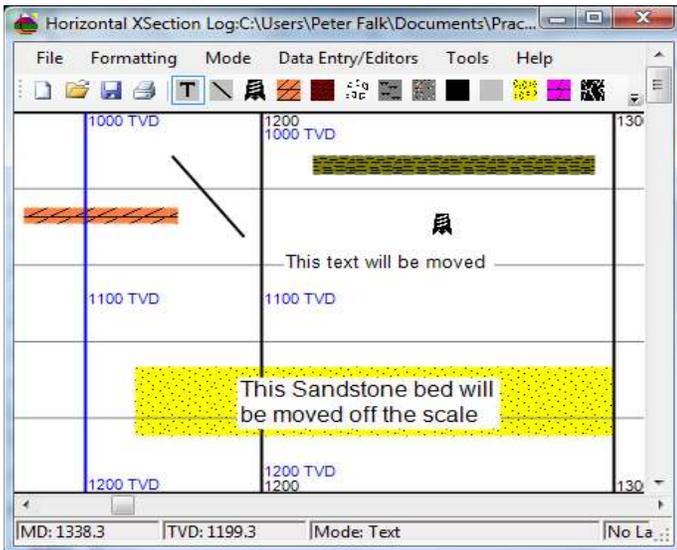


### The Effects of Adding a New TVD Scale

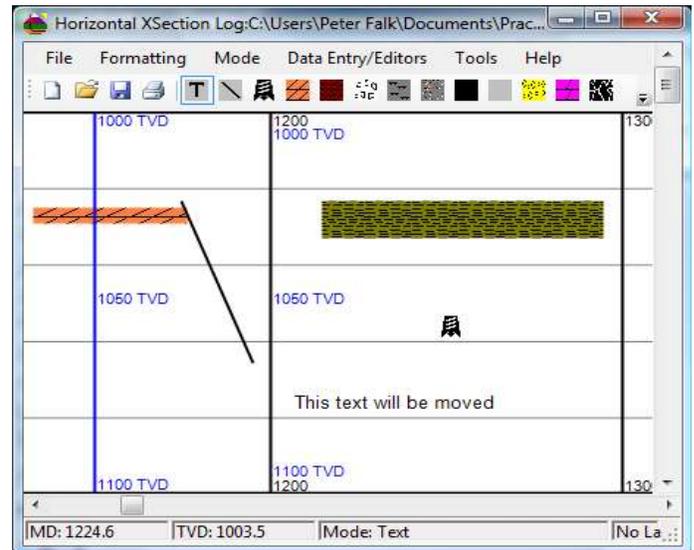
If you create a new TVD scale, or change an existing scale, all text blocks, lines, images, TVD logs, and lithology beds in the area of the new scale, will be affected. However, changes in scales affect objects differently. For example, lithology beds as well as TVD logs, are dependent on the vertical scale of the TVD scale. If you change the vertical scale of a TVD scale from 200' to 100' (see below picture), all lithology beds in the new scale area will become twice as large. Moreover, lines will move in relation to the new scale. Images and text will move their position, but their size will remain the same. The location of all elements is dependent on the position of the upper left corner of each element. A scale change to the right of the left-hand corner of an object will not move or affect that object. The below

example shows what happens to different objects when the vertical TVD scale is changed from 200' to 100'. Notice the anhydrite (orange) lithology bed is not affected by the scale change because the left-hand corner of the element is to the left of the scale.

### Before Scale Change



### After Scale Change



A common occurrence when adding or changing scales is to move, either on purpose or accidentally, elements out of the viewing area (i.e. the sandstone and accompanying text above). The elements still exist in computer memory but are no longer visible. Change the scale back and the elements will appear again. It does not hurt anything, other than taking up memory, to have elements that are not visible, but if you feel the need to delete elements that are no longer visible, use the "Clean-Up Log Utility" in the Tool menu. This utility will delete all elements that are wholly and some elements that are partly out of the viewing area. The same is true if you shorten the log length (Formatting->Log Depths...).

### Format Lateral Curve Attributes

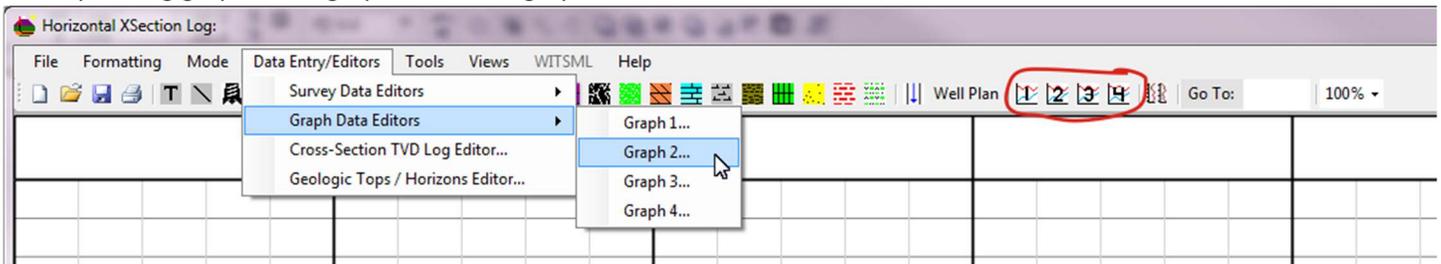
Use this menu item too format the lateral curve attributes like line, width, rotate color, slide colors, etc. This menu items is described in more detail in the Chapter "Getting Started" (Chapter 2), and anyway, is self-explanatory.

## Chapter 4 - Graph Data (ROP, Total Gas, Gamma, etc...)

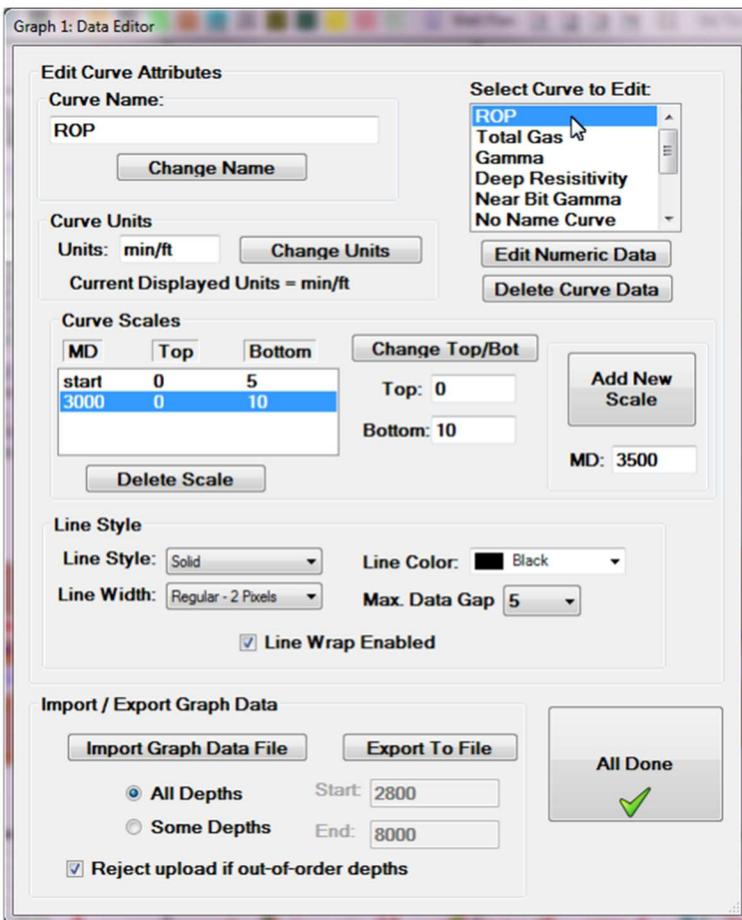
Horizontal XSection has four tracks, labeled Graph #1, Graph #2, Graph #3 and Graph #4, which are devoted to exhibiting data in a graph format. Usually this is drilling data, gas data, or MWD data. There are numerous ways to enter and edit the data.

### The Graph Editor

There are two methods to open the graph editor. The first is to click the menu item (on the main menu bar) Data Entry/Editors->Graph Data Editors->Graph 1..., Graph 2..., Graph3..., or Graph 4..., depending on which graph you want to edit. The other method is to click on the graph tool bar image (circled in Red in the below screen example) for the corresponding graph, 1 for graph one, 2 for graph two, etc.



The graph editor is divided into two Sections: The top section is called "Edit Curve Attributes", while the bottom section is called "Import / Export Graph Data".



The "Edit Curve Attributes" takes up most of the window and is where the Curve Name, Curve Style, Curve Scales and Curve Units can be edited and the curve data deleted or edited.

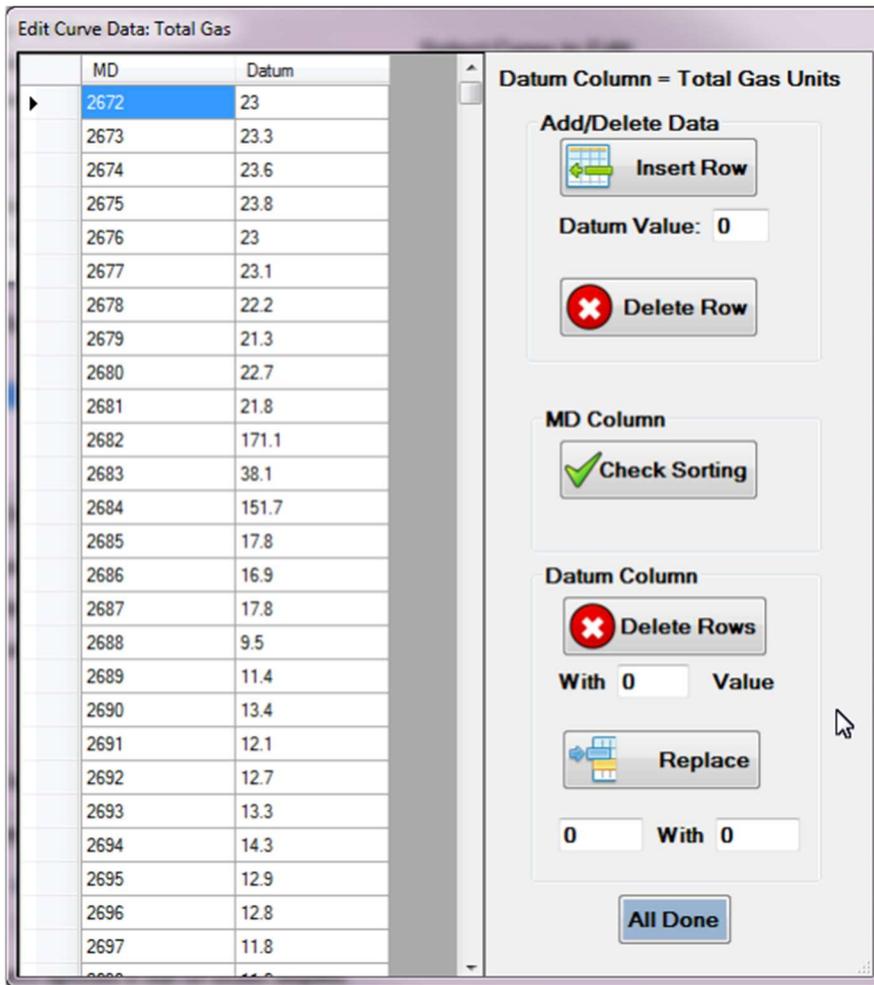
The first step is to choose one of the 10 curves (updated from 6 in version 2.0) from the "Select Curve to Edit" list that is at the upper right of the window. When a curve is selected, the characteristics of that curve are displayed in the different parts of the "Edit Curve Attributes" section. Use the drop-down lists in the "Line Style" section to change the line characteristics. To change the Curve name, Graph Units or the Curve Scales, type the new values in the text areas and click the corresponding "Change..." button for the changes to take effect. To delete the curve data, select the curve and click the "Delete" button. Similarly, to edit curve data, select the curve and click the "Edit Numeric Data" button.

### Editing Curve Data

Most graph data will be imported to the log either as text files or from \*.las files. But there are instances where it is advantageous to edit or enter data directing

using the Horizontal XSection editing features.

Select a curve to edit and click the "Edit Numeric Data" button to open the "Edit Curve Data" window (shown below).



The title of the window will be the name of the curves whose data is being edited. Use the data table on the left and edit the data as desired. The right-hand part of the window has features to help with editing the data. The insert button will add a row below the highlighted or active cell, with a MD value of one foot greater than the highlighted cell, and a datum value that is set in the "Datum Value:" text area. The "Delete Row" button will delete the row of the highlighted or active cell. The "Check Sorting" button checks for out-of-order values in the MD Column. The "Delete Rows" button will delete all rows with a value in the "Datum" column equal to the value set by the user in the text area below the "Delete Rows" button. Similarly, the "Replace" button will replace every value in the datum column, set by the user, with the replacement value, also set by the user. This is useful when you are importing LAS files received from a directional drilling company. Often times the LAS file will have a "-999.00" or "-999.25" for missing or bad

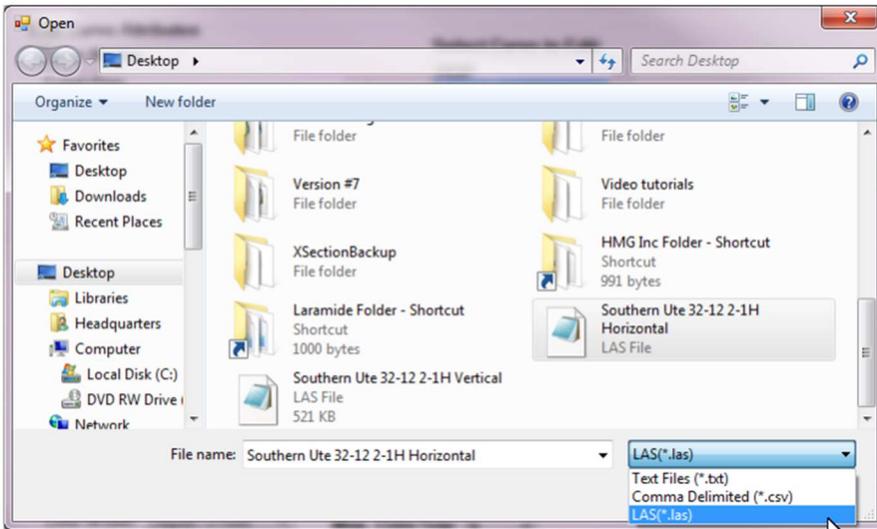
data. Use the above utilities to quickly delete or replace these bad values.

### Import Graph Data

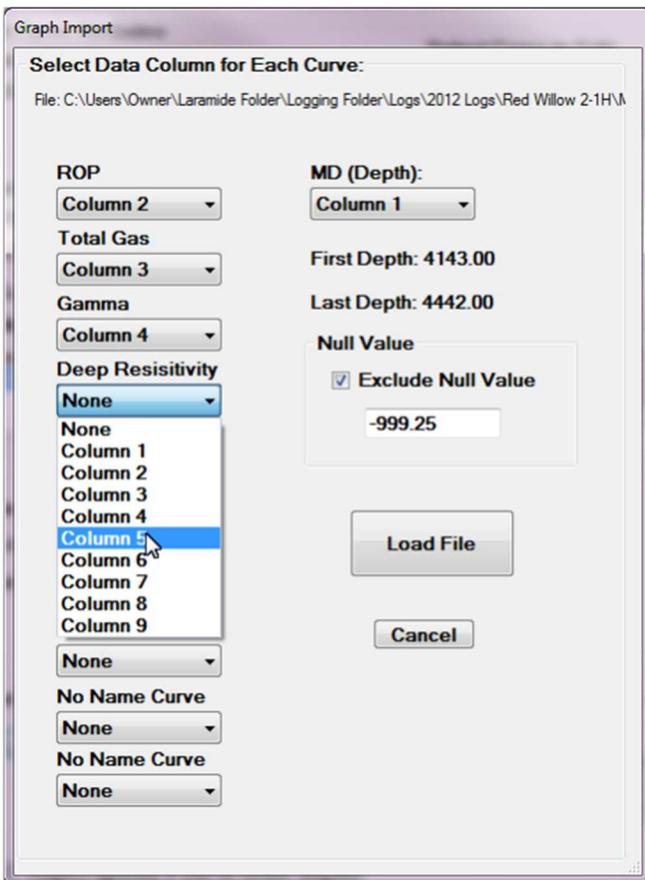
Usually, graph data will be imported. The Horizontal XSection can accept 3 types of files: text files (\*.txt) - either tab or space, comma separated files (\*.csv), and LAS files(\*.las).

Each of the different file types has their advantages. Text files are easy to create and can be edited in Windows Notepad. Comma separated files, are a type of text file that can easily be open by Microsoft Excel bypassing the "Text Import Wizard". If you are going to do a lot of editing of data using Microsoft Excel I suggest saving files in this format. Finally, LAS (\*.las) files are ubiquitous in the oil patch. Usually these will be files given to you by a third-party vender, like a WMD, Directional Driller or a download from an EDR.

To import data files for either graph track, open the graph editor as outlined above and click the "Import Graph Data File" button at the bottom in the "Import / Export Graph Data" section. Select the file type you wish to import (as shown in the screenshot example).



After a file is selected, a "Graph Import" window will appear that has drop-menus for each graph curve. The program assumes that the MD will be column number 1, though the user can change the MD column. It also displays the first and last value for the column the user chooses for the MD (Depth). For the other curves, the user needs to choose from the available columns in the drop down menu. This means that the user must know what column is for which curve before importing a text or a comma separated value file. When the appropriate columns have been chosen for the correct curves, click the "Load File" button. Once columns are selected for a particular graph track, the "Graph Import" window will remember the columns selected for each curve from the previous file upload session.



One advantage of importing LAS files is that the columns are delineated with a name that usually describes the data in the file.

### Overwriting Data

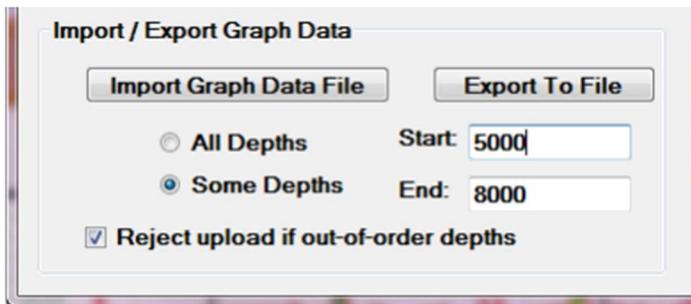
When data is loaded for a curve that already has data, the loading file will overwrite and delete any data after the first measured depth of the loaded file. For example, if you have ROP data from 1000' to 2000' MD and load a ROP data file that begins at 1900' MD and goes to 3000' MD, the loading file will overwrite the data from 1900' MD to 2000' MD. After loading this ROP data file, the ROP curve will have data that goes from 1000' MD to 3000' MD. However, if you were to then load an ROP file that goes from 2500' MD to 2600' MD, the program would overwrite the data from 2500' MD to

2600' MD and delete all the data from 2600' MD to 3000' MD. Hence, the curve would now have data that goes from 1000' MD to 2600' MD. The purpose behind this is to make it easy to add sidetrack data to an existing curve file, without having to delete any data by hand.

### All Depths / Some Depths

The import editor also gives the user the ability to upload all the data from a given file, or by selecting the "Some Depths"

radio button, selected depths for importing.



### Out-Of-Order-Depths

By default, the program will reject a file that has its MD out of order, unless the user un-clicks the "Rejects upload if out-of-order depths" check box in the "Graph Editor" window before loading a file. In which case, the program will load the file no matter the order of the MD column - this may result in a less-than-desirable graph. However, it is a simple

process to use the "Check Order" button and the "Delete Button" in the "Edit Curve Data" window, discussed earlier, to quickly clean up any out-of-order data.

### Linear or Semi-Log Scales

The graph tracks can employ either linear or semi-logarithmic scales. The selection is made using the formatting menu (See Chapter 2). The linear scale option allows for more customization of the log scale. Each curve may have a different scale, and scales can be changed numerous times for each curve. Moreover, top and bottom values can be changed and curve wrap can be enabled or disabled.

A graph with a semi-log scale has fewer options. The semi-log scale is useful for displaying curves with a wide range of values. Most often, a semi-logarithmic scale is employed for Total Gas and Gas Chromatograph data which records values in units and parts per million, respectively. Semi-log scales always have a minimum value of 1. Maximum values are set in the graph editor and can range from 100 to 1,000,000. The direction of the semi-log scale is either normal (higher values at the top), or reverse (higher values at the bottom) and are set in the formatting menu for the particular graph in question. No scale changes are allowed in a semi-log graph, and all curves share the same scale minimum and maximum values.

### Export Files

The program also allows user to export individual graph curves as single tab-delimited text (\*.txt) files or comma separated files (\*.csv).

The survey data is at the center of the Horizontal XSection Log software, and understanding how it is employed by the program will make your use of this software easier and more productive. This chapter goes into detail about the how to enter, edit, import and export survey data, and the importance of the survey data to the program.

### Glossary of Terms and abbreviations:

**MD** - Measured Depth.

**INC** - Inclination of the survey tool where 0° is vertical and 90° is horizontal.

**AZ** - Azimuth of the survey tool corrected for magnetic declination (0° - 360°).

**TVD (KBTVD)** - True Vertical Depth is the vertical distance from the KB to the survey tool – also known as KBTVD.

**VS** - Vertical Section is the horizontal distance from the well location to the survey tool projected to a vertical plane that is the azimuth from the well location to the "planned" final target location.

**NS** - North/South, also known as Northings, is the map-view north/south coordinate for the survey tool. Positive numbers denote a coordinate north of the well location while negative numbers denote a southern location.

**EW** - East/West, also known as Eastings, this is the map-view East/West coordinate for the survey tool. Positive numbers denotes a coordinate east of the well position, while negative numbers denote a western location.

**DLS** - Doglegs is the degree of curvature measured in degrees per 100'

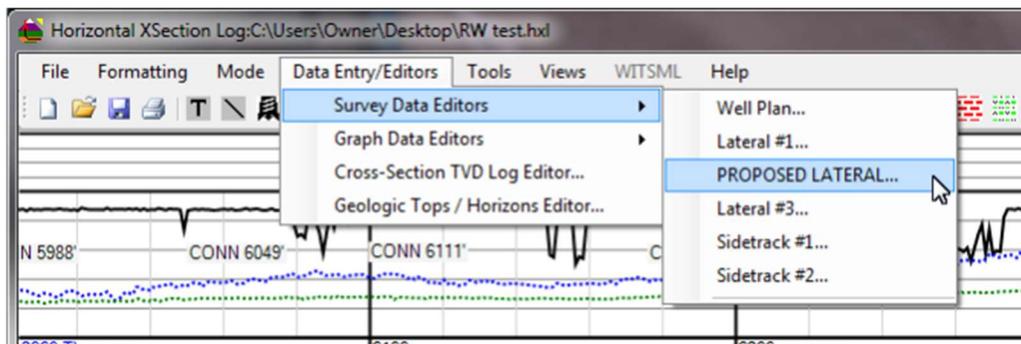
MD, INC and AZ, are measured by the down-hole survey tools (by the MWD personnel) and conveyed to the Directional Driller. TVD, VS, NS, EW and DLS are derived survey values. The dominate method of calculating the derived survey values is the Minimum Curvature method, and is the algorithm used by this software.

### The Tie-In Value

The tie-in value is the start point for any curve that will be represented in the Horizontal XSection software, and is the survey from which all subsequent surveys are derived from. The tie-in value can be any survey, but must include the MD, INC, AZ, TVD, VS, NS, EW, DLS, as well as the azimuth from the well location to the final target location. This value is often known as the "Direction" or the "Vertical Section along azimuth" value. Without a correct "Direction", the software will not be able to accurately calculate the Vertical Section.

Note: that the tie-in value need not be the same tie-in value that the directional driller (DD) employs. Since, often time the Geologist will not be concerned with the up-hole portion of the well, any survey can be used as a starting point.

To enter the tie-in value click on the menu item Data Entry/Editors->Survey Data Editors-> and the survey lateral to edit.



Lateral #1 Survey Data Sheet

**Tie-In Data**

MD	INC	AZ	TVD	VS	NS	EW	DLS
0	0	0	0	0	0	0	0

Edit/Add Tie-In Survey      Direction (vertical section along azimuth): 254.03

MD	INC	AZ	TVD	VS	NS	EW	Dogleg / 100'
6450	91.89	252.65	3026.10	3779.5	-1026.47	-3637.50	1.15
6511	92.33	252.4	3023.85	3840.5	-1044.77	-3695.65	0.83
6572	92.51	252.52	3021.27	3901.4	-1063.14	-3753.76	0.35
6638	92.33	252.81	3018.49	3967.3	-1082.79	-3816.71	0.52
6699	92.68	253.83	3015.82	4028.3	-1100.28	-3875.08	1.77
6760	91.45	253.36	3013.62	4089.2	-1117.49	-3933.56	2.16
6821	90.31	253.38	3012.69	4150.2	-1134.95	-3992.00	1.87
6883	90.75	253.49	3012.11	4212.2	-1152.62	-4051.42	0.73
6944	90.84	253.61	3011.27	4273.2	-1169.90	-4109.92	0.25
7005	91.71	253.59	3009.91	4334.2	-1187.12	-4168.42	1.43
7066	91.1	253.61	3008.41	4395.1	-1204.33	-4226.92	1.00
7127	90.04	253.04	3007.81	4456.1	-1221.84	-4285.36	1.97
7188	91.28	252.67	3007.10	4517.1	-1239.82	-4343.64	2.12
7249	90.92	252.7	3005.93	4578.1	-1257.97	-4401.86	0.59
7310	90.66	253.21	3005.09	4639.1	-1275.85	-4460.18	0.94
7371	90.57	253.59	3004.44	4700.1	-1293.27	-4518.63	0.64
7432	90.66	253.35	3003.78	4761.1	-1310.63	-4577.11	0.42
7494	91.19	253.19	3002.78	4823.0	-1328.47	-4636.48	0.89
7555	90.31	253.62	3001.98	4884.0	-1345.89	-4694.93	1.61
7616	91.71	253.41	3000.91	4945.0	-1363.20	-4753.41	2.32
7680	91.28	252.66	2999.24	5009.0	-1381.87	-4814.61	1.35
7743	90.75	253.38	2998.12	5072.0	-1400.26	-4874.85	1.42
7755	90.84	253.5	2997.96	5084.0	-1403.68	-4886.35	1.25
7833	90.84	253.5	2996.81	5162.0	-1425.83	-4961.13	0.00

Edit Survey    Add Survey    Import Surveys (\*.csv)    Done

Delete Survey    Export Surveys (\*.csv)

**Slide Report**

Add Slide Interval    Slide From:     Slide To:     Tool Face (optional):

Delete Slide

Start	End	Tool Face
2488	2580	25L
2587	2610	HS
2618	2640	HS
2648	2669	HS
2677	2699	HS
2741	2761	10R
2771	2791	HS
2801	2821	HS
2837	2852	HS
2866	2884	HS
2894	2913	10R
2930	2948	HS
2958	2980	10L
2988	3012	5L
3022	3043	10LL
3055	3075	10L
3089	3107	HS
3121	3139	HS
3193	3203	5R
3213	3234	5R
3252	3266	5R

Import Slides (\*.csv)    Export Slides (\*.csv)

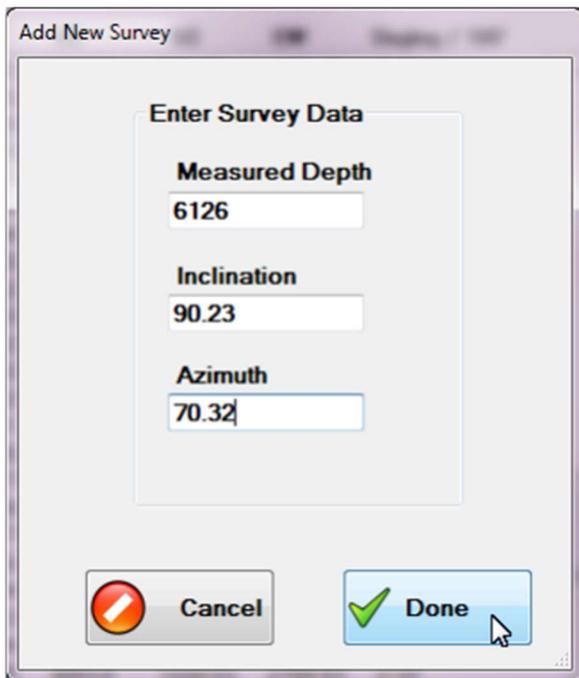
This will open the "Survey Data Sheet" window for the particular lateral chosen. Click on the "Edit / Add Tie-In Survey" button to open the "Add/Edit Tie-In" editor. Enter your tie-in survey data, as shown below.

Add/Edit Tie-In

MD	INC	AZ	TVD	VS	NS(Northings)	EW(Eastings)	Dogleg	Direction (degrees)
<input type="text" value="2564"/>	<input type="text" value="24.76"/>	<input type="text" value="188"/>	<input type="text" value="2554.29"/>	<input type="text" value="70"/>	<input type="text" value="-70.01"/>	<input type="text" value="-4.07"/>	<input type="text" value="7.81"/>	<input type="text" value="180"/>

### Adding, Editing and Deleting Survey Data

Once the tie-in survey is entered, new surveys are entered through the "Add New Survey" window(see below). Click the "Add Survey" button to open the "Add New Survey" window. Note that the "Add New Survey" window only asks for the Measured Depth, Inclination and Azimuth data. The program will compute the derived survey values(TVD, VS, NS, EW and DLS) and add the new data to the "Survey Data Sheet" window.



To edit or delete a survey, just select the particular survey and click either the "Delete" or the "Edit" buttons. Slide data is entered on the right side of the Survey Data Sheet and is self-explanatory.

To quickly enter survey data using the above displayed "Add New Survey" dialog window, use the "Tab" key to quickly move from field to field and press the "Enter" key (same as clicking the "Done" button) to enter and close the window; click the "Enter" key again to open the "Add New Survey" window for the next survey entry.

### Importing and Exporting Survey Data

Because it is often easier and faster to enter data in an Excel spreadsheet and then import the data into the Survey Data Sheets, the Horizontal XSection Log allows survey data to be imported and exported.

Use the "Import Survey Data (\*.csv)" and the "Export Survey Data (\*.csv)" buttons to import and export survey data, respectively.

However, the data must be formatted in a particular manner, and saved as a comma separated values file, also known as comma delimited text files (\*.csv), in order for the program to be able to load the file. The simplest manner in which to create a template is to use the "Export Survey Data" button to create a CSV file. This file can then be opened by Microsoft Excel, edited, saved, and then imported back into the Survey Data Sheet of the particular lateral in question. To create a template, choose one of the empty laterals and open the "Survey Data Sheet" as shown above. Enter a tie-in value and click on the "Export Survey Data" button to create a CSV (\*.csv) file. This file can then be opened in excel as shown below. If you double click a \*.csv file, excel should automatically open. From within Microsoft Excel choose "Text Files" to display files of type comma delimited (\*.csv).

Row	A	B	C	D	E	F	G	H
1	180	Direction						
2	MD	INC	AZ	TVD	VS	NS	EW	DLS
3	2564	24.76	188	2554.29	70	-70.01	-4.07	7.81
4								
5								
6								
7								
8								

The format of a template CSV file is simple:

CELL A1 has the direction data,  
 ROW TWO is used as a header for the survey columns,  
 ROW THREE holds the tie-in value and,  
 ROWS FOUR onward are used for the survey parameter MD, INC and AZ.

The below example shows an Excel file that is ready to be imported with some survey data added in rows 4 - 7. Make sure you choose CSV(Comma Delimited) when saving the file, and make sure you close the file before trying to import it into the Horizontal XSection

software. Then simply open the Survey Data Sheet window for the appropriate lateral and import the file. The other survey fields (COLUMNS D - H) in rows 4+ are ignored when imported into the Survey Data Sheet window. Horizontal XSection will recalculate these values when the surveys are imported.

Note, when surveys are imported into a Survey Data Sheet, all preexisting surveys, including the tie-in value, will be deleted. However, previously entered slide data is not be altered.

	A	B	C	D	E	F	G	H
1	180	Direction						
2	MD	INC	AZ	TVD	VS	NS	EW	DLS
3	2564	24.76	188	2554.29	70	-70.01	-4.07	7.81
4	2609	28.44	187.57					
5	2654	32.79	185.3					
6	2698	37.29	184.17					
7	2743	41.43	184.59					
8								

As noted above, survey data is exported as a comma delimited text file (\*.csv). The exported data includes all the derived survey values (TVD, VS, NS, EW, and DLS).

### Matching the Directional Drillers Values

Though there are other methods for computation of the derived survey values, the most common method on horizontal wells is the minimum curvature method<sup>vii</sup>. As long as the directional company is using this method, the values derived from the Horizontal XSection software will match the values from the directional driller. At times rounding differences will result in values that differ

by a few hundredths. If values differ by more than a few hundredths, examine your MD, INC, and AZ as well as the tie-in survey for date entry errors. Also remember that sometimes DD and MWD hands make mistakes too (though they may deny it)<sup>viii</sup>.

## Chapter 6 - Lithology Patterns and the Lithology Mode

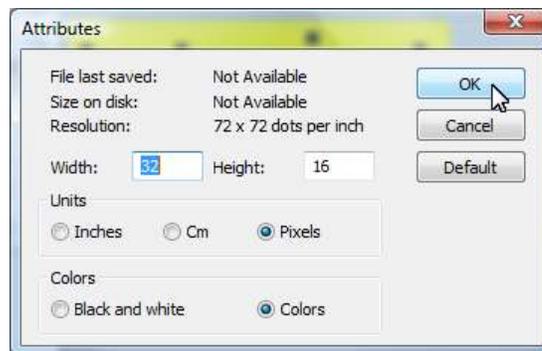
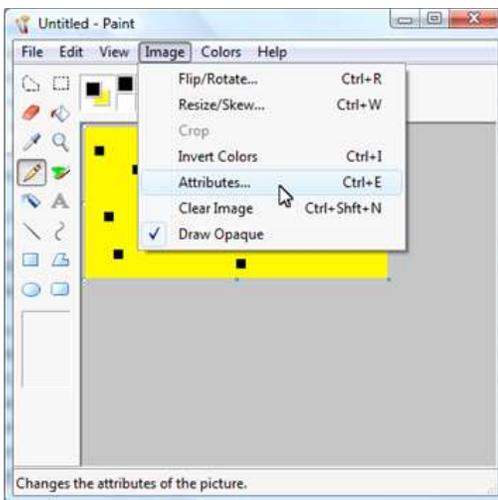
### Introduction

The Horizontal XSection program can store 20 lithology patterns. These patterns are stored as bitmap files (\*.bmp), which uses individual pixels to create an image. When you begin the program, it loads the default patterns (bitmap files) into memory. However, it is a simple process to load a custom set of lithology patterns, or to load and/or change individual patterns. The process, explained in "Chapter 3 - The File and Formatting Menu", for loading a file with pre-formatted attributes using the File->New menu item, will also load the files lithology patterns. Lithology mode allows you to draw horizontal, as well as dipping beds, add stringers and even put in faults.

### Creating Custom Patterns with Microsoft Paint

A nice property of bitmap files is that they are simple to create. Microsoft Windows OS all come with a program called "Paint", which is a primitive, yet effective way to create lithology patterns, as well as log images (See chapter on log images).

To create a custom pattern, first open the "Paint" program by clicking on Start->All Programs->Accessories->Paint. The lithology patterns used in Horizontal XSection Log should be 32 pixels wide by 16 pixels in height. To create a 32 x 16 pixel canvas, click on Image->Attributes..., to open the attributes window, and enter 32 pixels and 16 pixels in the width and height text areas, respectively. An alternative method is to right-click a bitmap file and click "open with" and select the "Paint" program from the list of programs.

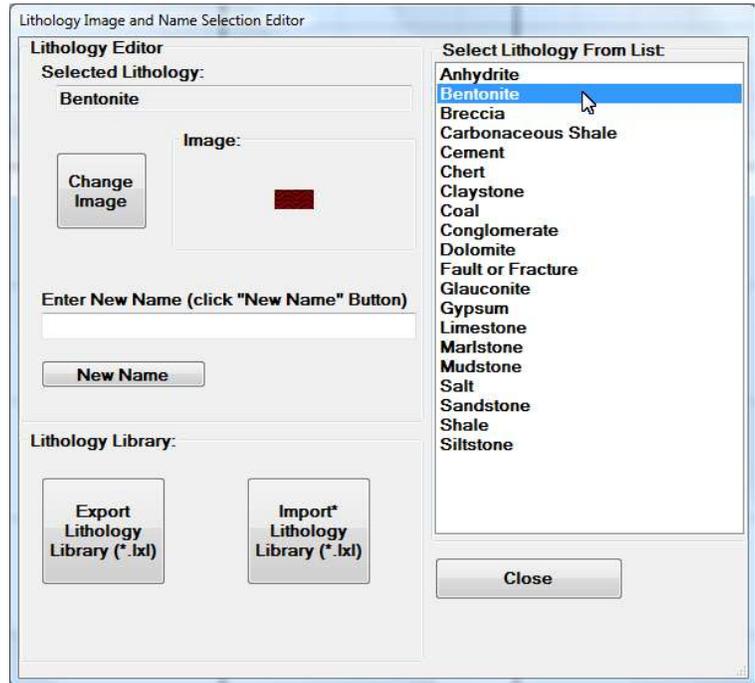
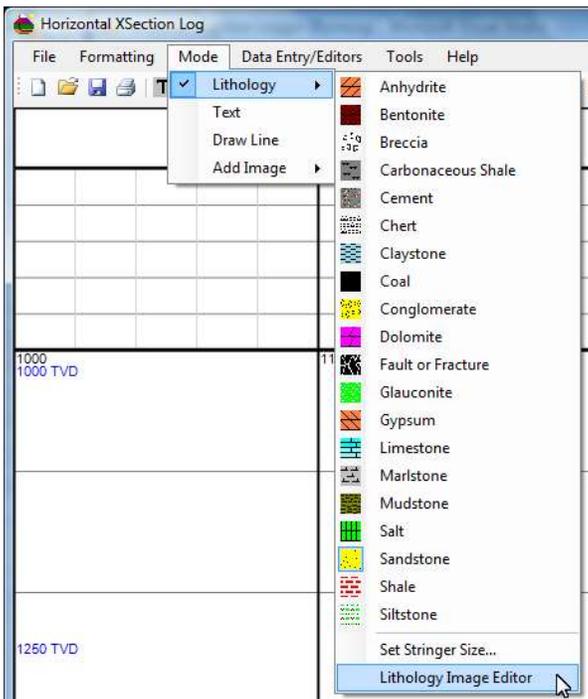


After closing the attributes window, click on View->Zoom->Custom->800% to enlarge the canvas area. This will make it easier to design your pattern. Create and save your custom pattern. It is recommended that you save patterns in the "Lithology Bitmaps" folder (this folder is found in the "XSection Utilities" folder located in "My Documents" or "Documents" folder).

### Importing Lithology Patterns

To import or change the name of a lithology pattern, open the "Lithology Image and Name Selection Editor" window by clicking on the menu item Mode->Lithology->Lithology Image Editor... (see below). Next, select the image from the right-hand side list of lithologies. Type in a new name for the selected lithology and click the "New Name" button, to change or edit the name. The new name will appear in the lithology list, the menu item Mode->Lithology-> "lithology list", and the log's Legend.

To import a new pattern, click the "Change Image" button for the selected lithology, and select the new bitmap file using the open file window.

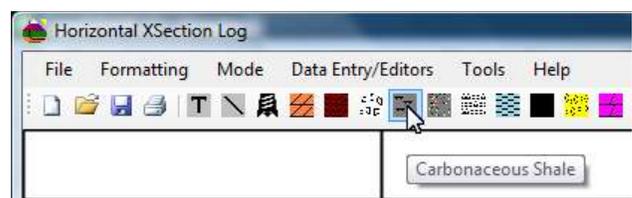
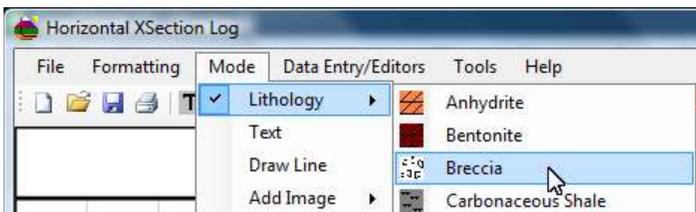


## The Lithology Library

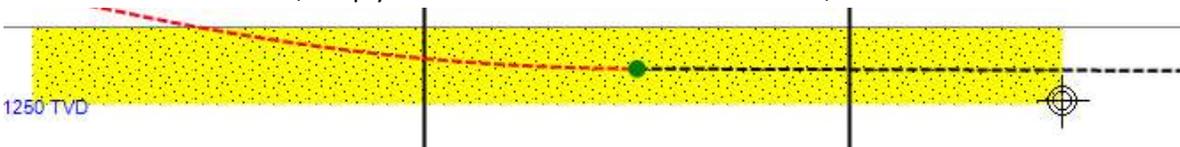
The lithology library import and export buttons are a simple way to import and export a complete library of custom patterns. Only import a lithology library at the beginning of a log session, before any lithology beds have been placed on the log, or sample percentages entered in the "Samples Track". When a lithology library is imported, all lithology beds in the "Cross-section Track" and samples in the "Samples Track" are deleted. A lithology library can be exported at any time. Personalized lithology patterns in a log are saved with the log. However, it is suggested that you use the export lithology library to backup your lithology patterns.

## Lithology Mode

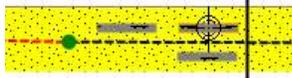
As mentioned in the Chapter 2 ("Getting Started"), there are five modes that allow annotation of the cross-section track. Lithology mode allows the placement of lithology beds. Lithology mode is automatically selected whenever a user selects a lithology pattern either through the Mode->Lithology->... menu or the toolbar. When in lithology mode, the mouse pointer will turn into a cross.



To draw a horizontal bed, simply click and hold the left-mouse button, and release when done.

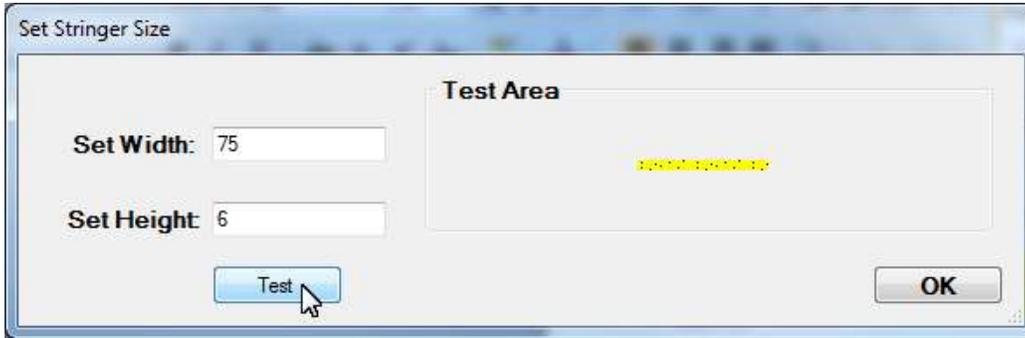


To put an interbedded stringer within a lithology bed, simply choose a different lithology pattern using the menu or the toolbar as shown above, and click once without moving the cursor. The program will draw a preset stringer centered



around the mouse click.

The stringer dimensions can be reset by the user. Open the "Set Stringer Size" window by clicking on Mode->Lithology->Set Stringer Size...,

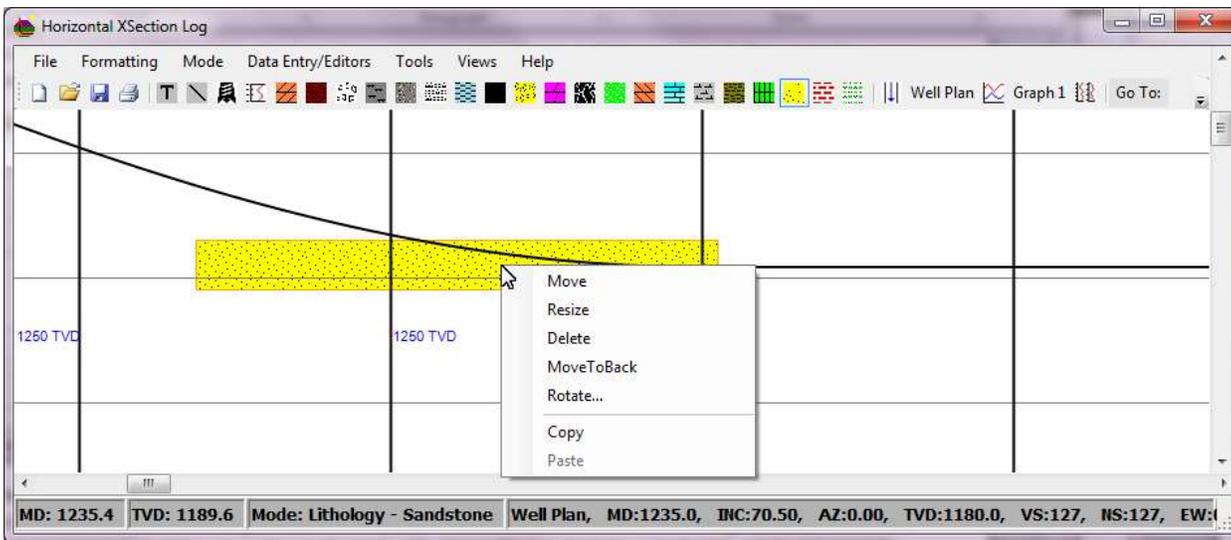


type in the new "Width" and "Height" dimensions in the appropriate text boxes, and use the "Test" button to view the new dimensions; click OK when you are satisfied with the new dimensions, and the new stringer size will be saved.

When the file that you are working on is saved, the new stringer size is also saved and will be loaded when the file is reopened. If a new file is created using the File->New menu item, the stringer size will be reset to the default size of 40 pixels wide by 6 pixels in height.

### Delete, Move, Rotate and Resize Lithology Elements

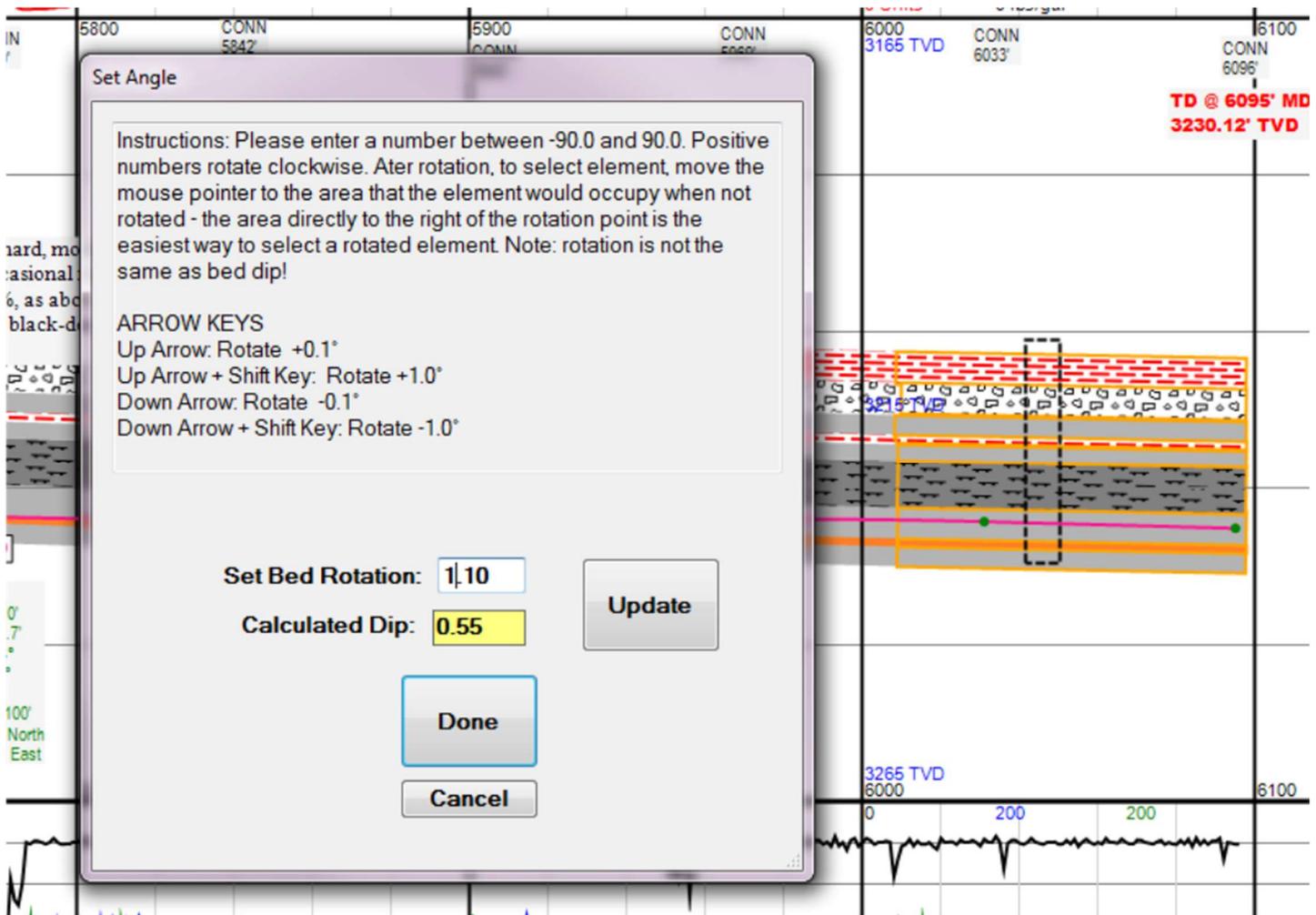
To delete, move, rotate or resize a lithology element, the user must first be in "Lithology Mode". Then move the cursor over any lithology bed or stringer until an orange outline appears, then right click the mouse to open the popup menu.



The "Move" and "Delete" items are self-explanatory. The "MoveToBack" feature will move the selected bed or stringer to the back, so that other lithology beds will be displayed over that bed. If this sounds confusing, first draw a few smaller beds (or stringers), and then cover the smaller beds with a larger lithology bed. Now use the MoveToBack item on the last larger bed that you drew covering the smaller beds, and the smaller thinner beds should reappear over the larger bed. Horizontal XSection draws lithology beds in the same order that they were created, and the "MoveToBack" feature reorders the drawing queue by moving the selected bed to the front of the queue. The "Resize" menu item can be used to lengthen or shorten the width (but not the height) of a lithology bed.

## Rotate

The "Rotate" menu item will open up 'Set Angle' window. There are many different ways to rotate a lithology bed with this window. The simplest is to use the up/down arrow keys on the keyboard.



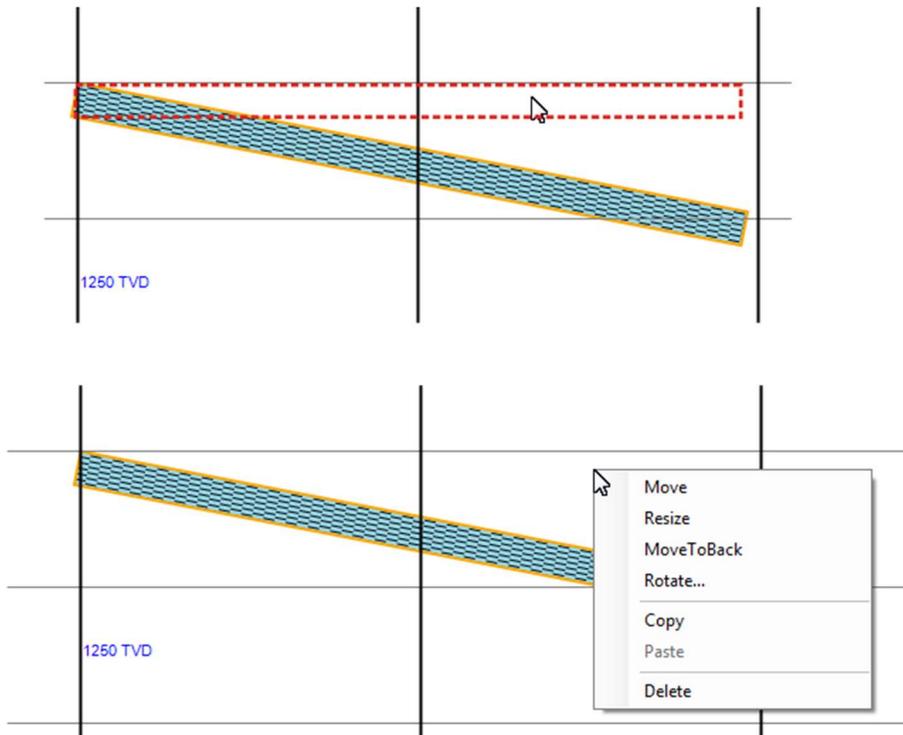
Each depress of the up or down arrow key will rotate the bed by  $\pm 0.1^\circ$ . With the shift key depressed, the increment will increase to  $\pm 1.0^\circ$ . Or, the user can enter a number between  $90^\circ$  and  $-90^\circ$  and then depress the update button. Bed rotation refers to the degrees of rotation shown on the computer screen and is not analogous to the apparent dip of said rotation. The apparent dip depends on the TVD scale on the log where the bed is being rotated. However, the "Set Angle" window will calculate the apparent dip of the bed from the rotation angle. In the above example, a  $1.10^\circ$  angle calculates to a  $0.55^\circ$  dip. Positive dip values are below horizontal (below  $90^\circ$ ), negative dip values are above horizontal (above  $90^\circ$ ).

It is fine to enter fractions, for example 0.5 degrees or 2.3 degrees are perfectly valid values. Note, the software will automatically adjust the degrees of rotation if the height dimension of the cross-section is changed (see Chapter 3: Formatting and the File Menu), so that the rotated beds "fit" the new height. However, changing the TVD scale will not affect the rotated beds. Hence, make sure you that you are happy with your TVD scale prior to rotating beds. Also, note that rotating horizontal beds will slightly distort the "look" of your lithology patterns. This distortion will only occur on the computer screen, not on logs printed on paper, and has to do with the finite resolution and grid-type pixel-format of computer monitors.

**Note: the degree of rotation of a lithology bed is not the same as the apparent dip. Due to the vertical exaggeration of most logs, the degree of rotation will be greater that the apparent dip.**

## Selecting a Rotated Bed

A rotated bed can be selected, and hence, moved, deleted and rotated (again), just as a non-rotated bed. However, selecting a rotated bed can be tricky, especially if the bed is rotated to a high degree. To select a rotated bed, move the cursor to the position of the bed if it were not rotated.



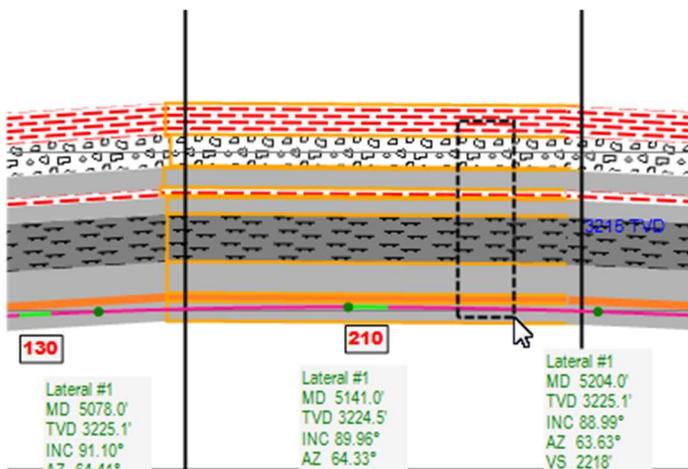
## Copy and Paste

A lithology bed or beds (if grouped, see below) may be copied and pasted. One nice attribute of the copy and paste feature, is that rotated beds that are copied will be pasted with the same degree of rotation.

## Group Lithology Beds

With the release of the Horizontal XSection Version 2.0+ there is now the ability to group lithology beds together for editing purposes. To group lithology beds together, hold down the shift key while moving the mouse cross-hairs (must be in "Lithology" mode) over the lithology beds of interest. The orange border that appears when a lithology bed

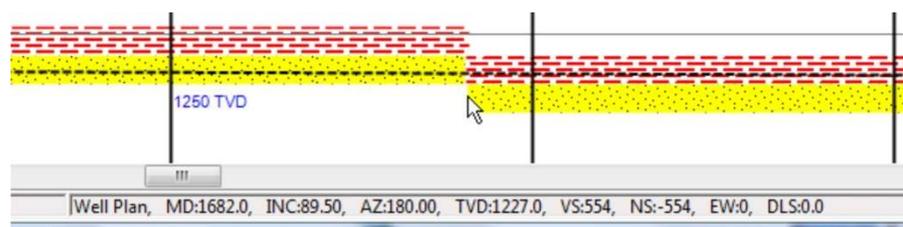
is selected will remain selected even after the mouse has passed over the lithology edge as long as the shift key remains depressed. The program will draw a slotted rectangle, any bed within the rectangle will be grouped; then right-click the mouse key to select the desired action. Only 'MoveToBack' will not work on grouped lithology beds.



Following the steps shown in the figure above, it is now simple to select multiple lithology beds and either move, resize, rotate or copy and paste.

## Creating a Fault

Displaying faults in the cross-section is simple. The first step is to draw your lithology beds showing the displacement of the lithology. The below example is an example of how to show displacement of a shale overlying a sandstone, wherein the borehole goes from drilling a sandstone (the pay zone) into drilling a shale at ~1682' MD.



To show the fault, select the lithology pattern "Fault or Fracture" from the menu or tool bar, and draw a vertical strip as shown below; then add a -5.0 degree rotation to the fault to give it a more

realist display of a normal fault, and add an arrow using the draw line feature!

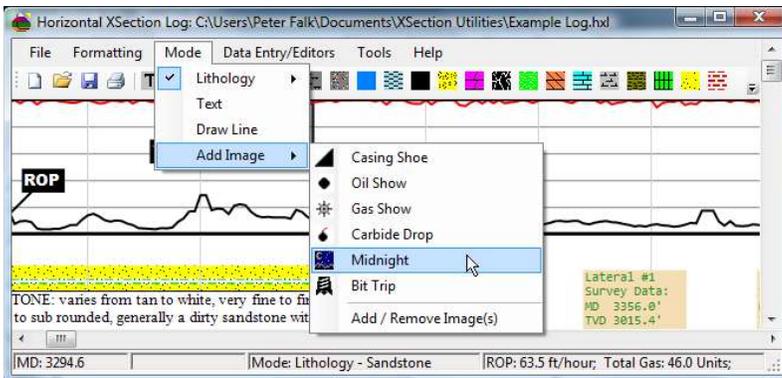


## Chapter 7 - Log Images and Photos

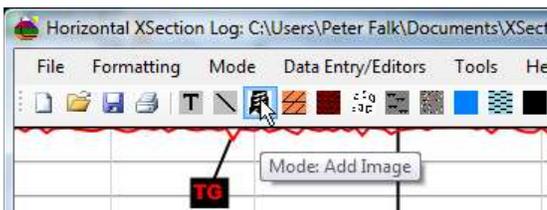
The Horizontal XSection software has an editing mode called "Add Image" that is devoted to adding images to your log. Images may include custom created symbols or events, photo's, or any image type that can be saved as a JPEG, Bitmap or TIFF file type. Presently, images may only be added to the cross-section track of the log<sup>ix</sup>. There are a number of log images that are preloaded into the "Add Image" dropdown menu when Horizontal XSection is opened<sup>x</sup>. Moreover, there is an extensive library of images for your perusal and use in a folder called "Log Images", found in the "XSection Utilities" folder. The Horizontal XSection Log makes it a simple process to add an image to the "Add Image" queue.

### Log Mode

To change the mode to the "Add Image" mode, either click an image from the "Add Image" dropdown menu,



or select the "Add Image" icon from the toolbar.



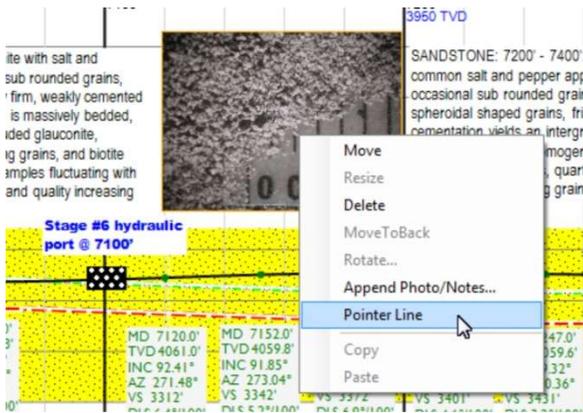
The Icon image in the toolbar represents the image that will be added to the log and will change only when a different image is selected from the main menu "Add Image" dropdown menu. In the example at left, the "Bit Trip" image will be selected by clicking on the toolbar "Bit Trip" image.

Image Add icon.

In "Add Image" mode, simply click anywhere on the cross-section track of the log to add the selected image to the log. The upper-left corner of the image will appear at the click point. To Delete or Remove an image, move the cursor over the image until the orange bounding rectangle appears, and then right-click to open the popup menu. The "Move" and "Delete" menu items will be enabled. If you select "Move" by right-clicking the "Move" item from the popup menu, move the image to the desired position and left-click to "drop" the image. The "Delete" item works similar to the "Text", "Lithology", and "Draw Line" modes.

### Pointer Line Attached to Photo's or Log Images

Like text blocks, a pointer line can be attached to a Photo or Log Image. Simply right-click the log image or photo, and select pointer line from the popup menu. To move the pointer line, move the cursor over the end of the pointer line and right-click when the orange selection rectangle appears, and select "Move" from the pop-up menu. Move the mouse to the new point (the pointer will follow) and then left-click the mouse. To remove a pointer line from the associated image or photo, follow the same process as selecting the pointer line. When a photo or log image has an associated pointer line, the pointer line will have a check mark selection marker in the popup menu. Each photo or log image may only have one associated pointer line.

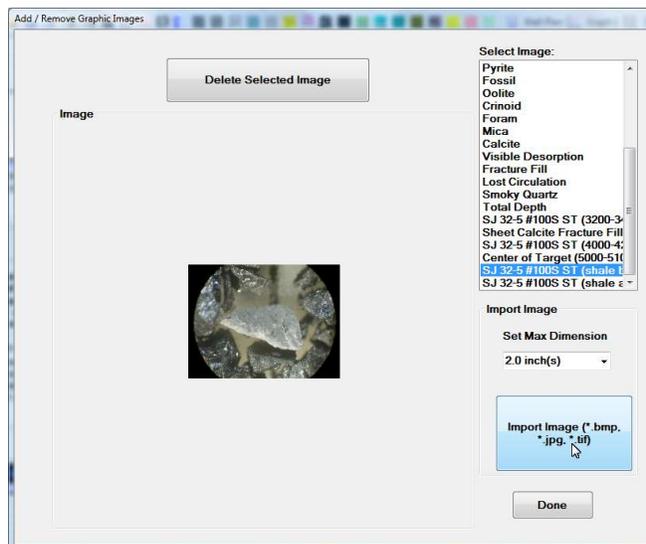
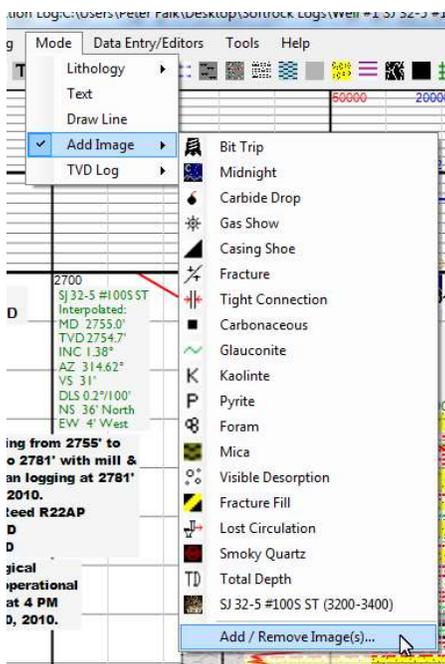


**Note:** it is advised to use the associated pointer line rather than the draw line feature with photos or log images. The reason is so that when the zooming feature is employed, the associated pointer line will be scaled correctly with the Photo or log image. This may not be the case with a line drawn using the draw line feature.

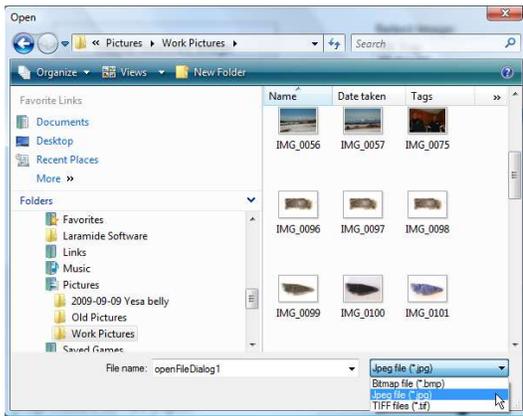
### Adding / Removing Images to the Add Image Dropdown Menu

Horizontal XSection makes it very easy to add images to the Dropdown Image list. Note, that all images under a quarter of an inch in height and half an inch in width<sup>xi</sup> that are displayed in the "Add Image" dropdown menu, will also appear on the log legend, when the log is printed. The legend can hold about 25 images. It is also very easy to remove images from the dropdown menu. Note, however, when an image is removed from the drop down menu, those same images on the log are **not** removed.

To remove or add images to the "Add Image" dropdown menu, open the "Add / Remove Graphic Images" window by clicking on the "Add / Remove Image(s)..." menu item as shown below. To delete an image, select the image from the "Select Image:" list and click on the "Delete Selected Image" button.



To import a bitmap, jpeg or tiff image to the "Add Image" drop-down menu, click the "Import Image (\*.bmp, \*.jpg, \*.tif)" button, which will open the "Open" file window. Presently, you are limited to importing the following file types: Bitmap's (bmp), JPEG's (jpg) and TIFF's (tif). However, this should cover the types of images most users will want to import. Use the dropdown menu in the lower-right corner of the "Open" file window to choose the file type of the image that you want to import.



After you choose the image with "Open" file window, you will be prompted to give a name to the image that you are importing. The image name does not need to be the same name as the file that is being imported, and will be the name that appears in the dropdown menu, and on the log legend.

### Creating Bitmaps

The simplest way to create log images like fossils or accessory minerals, is to use the "Paint" program that is part of the Microsoft Operating System (also see chapter 6 - creating patterns) :

- 1) Open paint by clicking Start->Programs->Accessories->Paint.
- 2) On the Paint programs menu bar click on Image->Attributes (or ctrl-e) and set the width to 15 pixels and the height to 16 pixels. Larger or smaller images may be created, however, the image shown on the XSection menu will be distorted to fit the dropdown menu image space . The image drawn on the log, will be exactly the same as the image created in the Paint program.
- 3) On the paint programs menu bar click on View->Zoom->Custom->800%.
- 4) Create your design and save it to a location you will remember as a bitmap (\*.bmp). You may also save the images as jpeg's and or tiff files.

### Bitmap Library (Log Images - XSection Utility Folder)

When the Horizontal XSection program is installed on your computer, a folder called "XSection Utilities" is created in the "Documents" section of your computer. This folder contains a folder called "Log Images", which contain three folders ("Fossils", "Minerals" and "Misc Images") with an assortment of bitmap images that can be loaded into the program for your use.

### Importing Photos and the "Set Max Dimension"

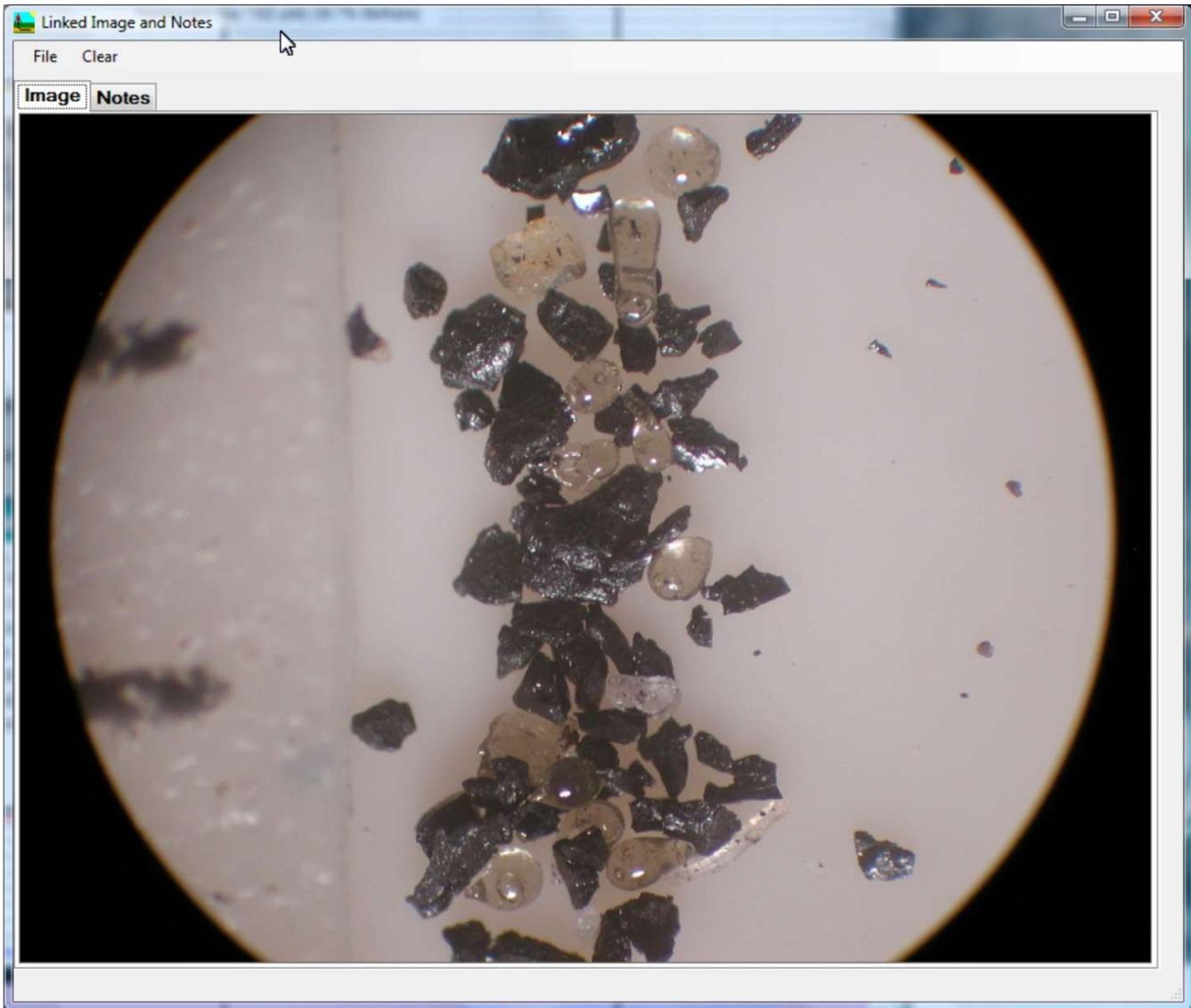
Most photos will be saved as JPEGS. When importing a photo into the "Add Image" queue, the software will resize the image so that the largest dimension is no greater than the "Set Maximum Value" selection. Hence, there is no need to resize photos before importing them into the program. Use the drop down menu to select any maximum dimension from 1" to 5" (in 0.5" increments). Once you are done adding photos to the log, you may delete the photo from the "Add Image" queue. Deleting the photos from the "Add Image" menu will decrease the size of the log file (\*.hxl), without affecting the photos in the log. Photos in the "Add Image" menu will not appear on the log legend when the log is printed.

**Note: Be careful when changing the cross-section height dimension (see chapter on formatting) or the log scale because the size of photos (and all log images) are not affecting by changing the size of the cross-section dimensions in the way that other elements (i.e. Lithology beds) are affected. Hence, a one-inch photo inserted into a log will always be a one-inch photo regardless of cross-section track dimensions.**

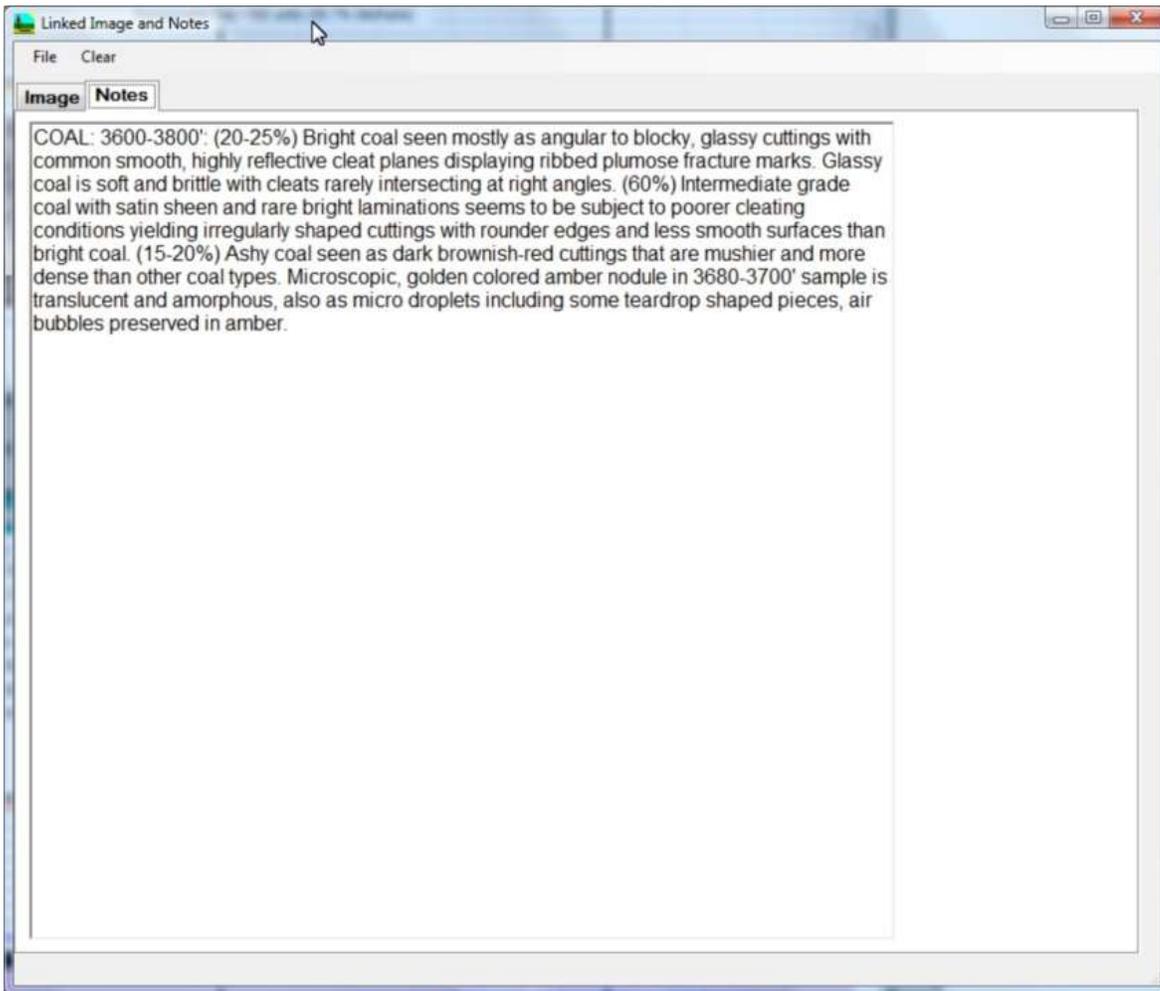
## Append Photo (or any Image), and Text to any "Log Image" or Photo Thumbnail

Photos and text can be added as an appendage to any log image or photo by simply selecting the photo or image and right-clicking the mouse. For example a large photo can be appended to a photo thumbnail on a log. The appended window has two tabs, one for photos or other images, the other for text. The below example<sup>xii</sup> shows each tab reduced ~30% to fit in this manual.

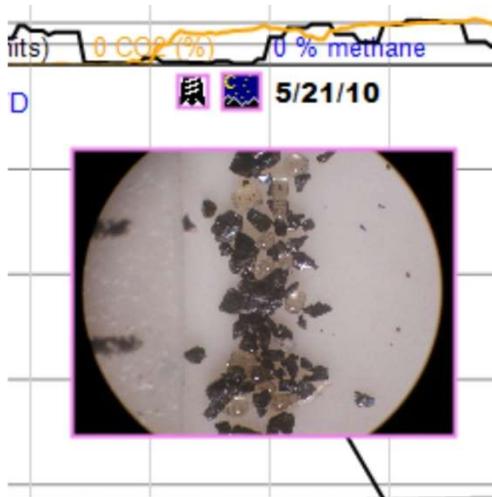
*9" X 6.75" Photo display*



*Add Descriptions, reports, casing information, bit info etc...*



When a log image has an appended note or image, that log image will have a constant violet colored border. The below example shows a "Bit Trip" image with an appended bit report (not shown), a thumbnail with an appended image (see above) and a "Midnight" symbol with an appended midnight report.



The image tab displays a 9.00 X 6.75" photo. The program will automatically resize large photos to fit in the available space. The method of importing an image is to "drag and drop" the selected image into the image tab in the 'Append Image/Text' window.

How one selects to open the appended images or notes depends on whether one is using a licensed version or the log viewer version of the Horizontal XSection Log:

- In the log viewer, click on any log image with a violet border.
- With a licensed version, first select "Add Image" from the mode menu or toolbar, then right-click over the 'Log Image' or photo and select "Append Photo/Notes..." from the popup menu (see first image on pg. 2).

Possible uses of this new feature:

- Link large photos to embedded photos.
- Link a "Show Report" in the text tab to a "Show" (oil or gas) image

- Embed morning or afternoon reports to a AM or PM report image. There is now a default "AM and PM Report" Log Image as part of the default log. Or go to "C:...\\Documents\\XSection Utilities\\Log Images\\Misc Images" to add the AM or PM report images to the 'Log Image' menu.
- Similarly embed Frac reports for each staged fracture to a frac report log image.
- Add Correlation images exported from the Geosteering tool.

### Log Size

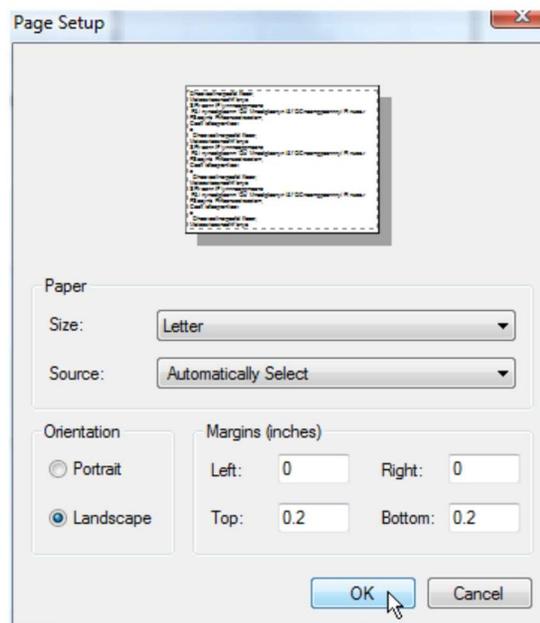
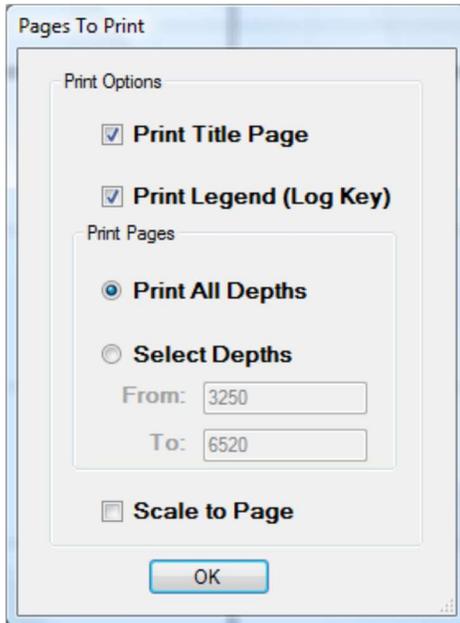
Appending a photo that fills the 9" X 6.75" image tab will increase the size of the log by ~1MB. As a test, a log with 7 thumbnails with appended photos was ~9.5MB. High-speed internet connections on a well-site location are often slow or sporadic, and emailing a log with many appended photos can be difficult. In these situations, it may be advisable to wait until a high-speed internet connection is available before appending photos and emailing large MB log files (\*.hxl).

## Page Setup

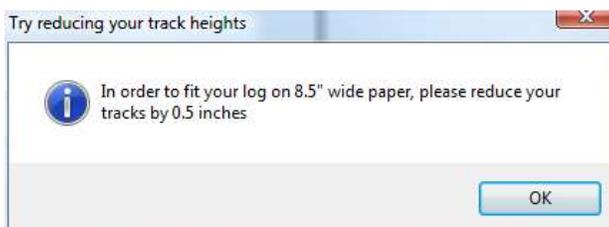
The first step in printing your log is to click on the File->Page Setup menu item to open the "Pages to Print" and the "Page Setup" windows, which appear in successive order.

*First*

*Second*



The "Pages to Print" window allows the user the options of choosing the printing interval, whether to include the title page and legend, and whether to "Scale to Page". After clicking OK, the Page Setup window will appear. By default, the page orientation will be set to "Landscape". Also, by default, the "Left" and "Right" margins are set to zero. It is suggested you keep this default value at zero. The "Top" and "Bottom" values are set by the program to center the log in the center of the page. If the total log height of all your tracks is greater than 8.0" and you have not checked the "Scale to Page" box, you will get this warning message (see below) between the Pages to Print window and the Page Setup window:



It is fine to disregard the warning, for example, if you have paper that is wider than 8.5 inches, or are printing in portrait mode, or are not concerned about fitting the log on the paper. Otherwise, use the Horizontal XSection formatting windows to reduce the log height (see "Chapter 3 - The File and Formatting Menus"), or

select the "Scale to Page" option.

## Scale to Page

The best way to use the software is to set the sum of all the track heights to no more than 8". If the user wants to see a larger log on their computer screen, the zoom feature works well. By setting the track heights to a cumulative height of not more than 8", printing on 8.5" wide paper is a snap. However, if the log height is much greater (or less) than 8.5 inches the "Scale to Page" feature in Page Setup will print an accurate log.

Check the "Scale to Page" box if prefer to have the program scale the track heights to fit on 8.5" wide page printing in landscape mode. When this feature is enabled, the software will either increase or decrease the heights of all the enabled tracks so that the sum of the track heights is 8". Lithology beds, lines, text location and TVD logs will all be

scaled and moved accordingly. Even the rotation of lithology beds should be accurately changed. However, images and text fonts will not be altered, so there may be differences between what is on the computer screen and what is printed. This is especially true if you are using the "Scale to Print" feature to reduce the log size by greater than 10%, so use this feature carefully.

## Printing

Once the "Pages to Print" and the "Page Setup" has been set, simply print the log using the "Print" menu item or the print icon on the toolbar. When you click the "Print" menu item or tool bar, the print dialog window will appear. Use this window to select the appropriate printer as well as to select banner printing, if appropriate.

## Print Preview - creating a PDF file

Presently, there is no print preview ability in the Horizontal XSection software. However, there is a simple way to preview your printed logs by creating a PDF file of your log<sup>xiii</sup>. Go to

<http://sourceforge.net/projects/pdfcreator/>

and download and install the PDF creator on to your computer. This software is free and easy to use. When you are ready to print your log, choose the PDF creator from the choice of printers.

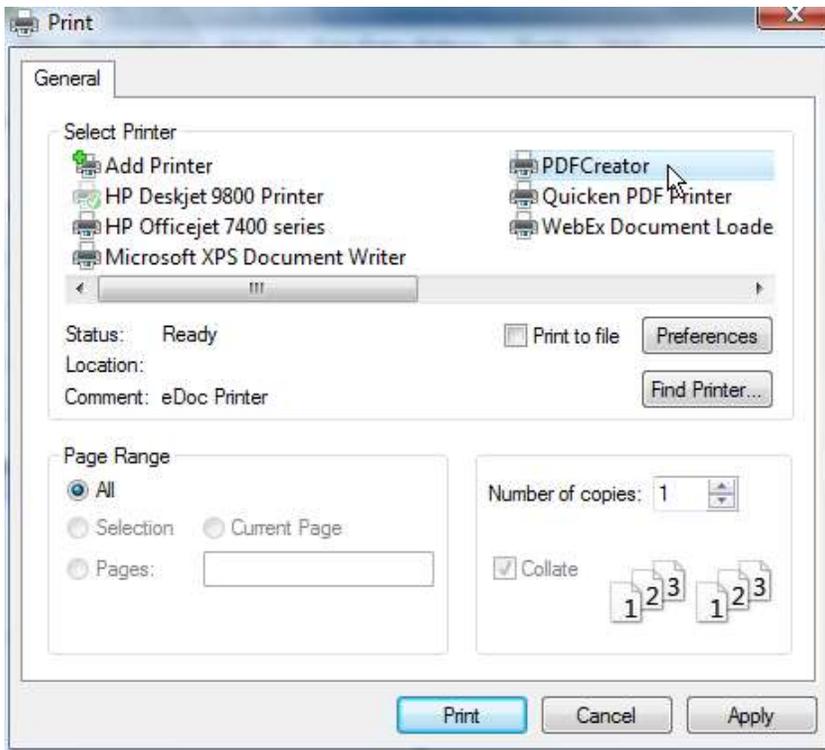
Rather than printing the log to the computer, the PDF creator will create a PDF file of your log that is exactly the same as if you had printed the log to paper. In this way you can proofread your log, as well as ascertain the page length of your log, or send the PDF file to clients so that they can print out the log.

**WARNING:** there are some problems with creating a PDF file using the above mentioned procedure. First I have tested a lot of PDF

printers and they all create TVD Logs on the cross-section that are 100% opaque, even if the opacity setting of the TVD log was less than 100% (i.e. 50%). This is not an issue with my program but with the PDF printers! Second, on some computers it was necessary to set the PDF printer as the default printer in the control panel, otherwise the program would not successfully create a PDF file.

## Continuous (Banner) Printers

Continuous banner printers have become much harder to find. I have had good luck with a printer sold by Well Green Tech ([http://www.wellgreentech.com/Well\\_Log\\_Printer.html](http://www.wellgreentech.com/Well_Log_Printer.html)).

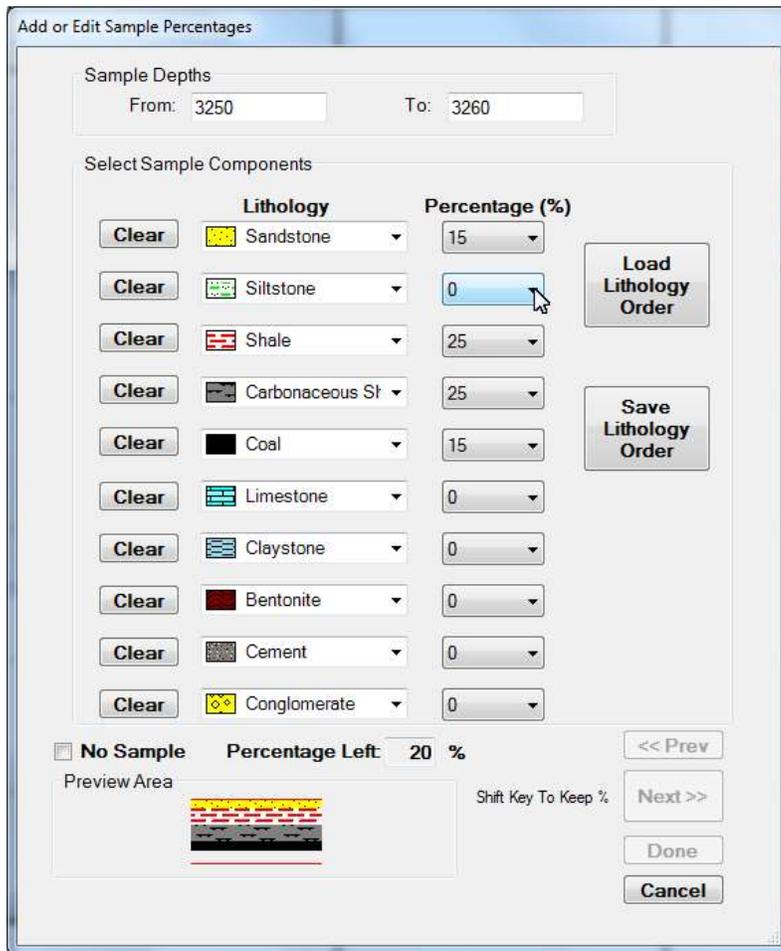
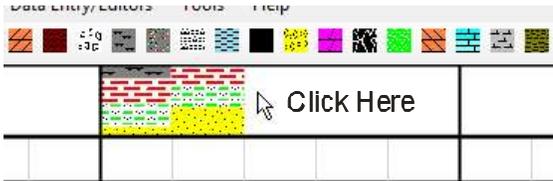


## Chapter 9 - Sample Track, Histogram Track and the Tools and Views Menu

The sample and histogram tracks use a similar user interface for entering data. The tools menu offers a variety of options for improving your log, and making your log editing experience faster and easier.

### Adding Samples Data to the Sample Track

The first step is to format the sample track using the Formatting->Sample Percentage Track menu item, as discussed in "Chapter 3 - The File and Formatting Menus". To enter sample percentage data, simply click on the "Sample Percentage" track as shown below.



Lithology	Percentage (%)
Sandstone	15
Siltstone	0
Shale	25
Carbonaceous St	25
Coal	15
Limestone	0
Claystone	0
Bentonite	0
Cement	0
Conglomerate	0

Percentage Left: 20 %

For example, if you are entering data from the sample 3250' - 3260' interval, click at between 3250' and 3255'. This will open the sample percentage editor with the correct sampling depth interval as shown below.

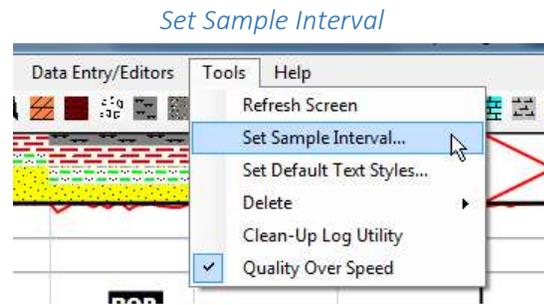
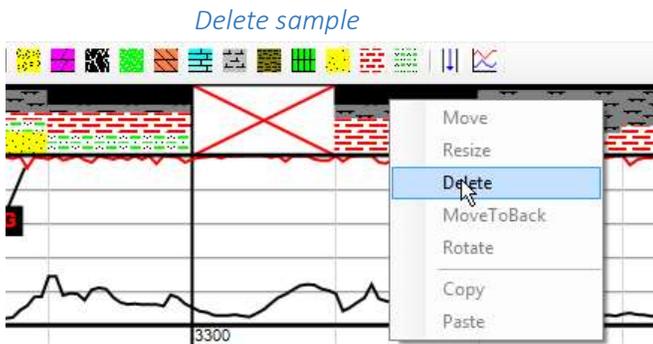
You can enter up to 10 different lithology components into each individual sample. Samples can be broken down into 5% component increments. However, it is suggested that for a "Sample Percentage" track height set at less than 1", avoid a 5% only component because it will barely be visible due to the finite resolution of most computer screens.

As components are added, the "Percentage Left" value decreases. Also, a preview area shows what the sample interval will look like on the log. Only when the "Percentage Left" is 0, will the user be able to click either "<<Prev", "Next>>" or "Done". The "<<Prev" and "Next>>" buttons will enter your selection and increment the sample interval up or down hole, respectively. The "Done" button will enter the selection and close the window.

**New Feature:** Depress the shift key while clicking the "Next>>" button to advance to the next interval

while retaining the same lithology % for each sample component.

Use the "Save Lithology Order" and "Load Lithology Order" buttons to save and load, respectively, the lithology components. Clicking on a sample interval that already has sample data, will open the "Add or Edit Sample Percentages" editor, preloaded with the appropriate data. To delete a sample interval, move the mouse over the sample interval to be deleted and right-click to open the pop-up menu, and then select "Delete" as shown below.



If the "No Sample" check box is clicked, a red X will appear at the corresponding sample interval (see above).

When a Horizontal XSection session is started, the default sample interval is 10'. Use the menu item Tools->Set Sample Interval... to open the "Set Sample Interval" editor, and change the sample interval as desired. Note the default sample interval is used for both the "Sample Percentage" Track and the "Histogram" tracks.

### Improved Histogram Track

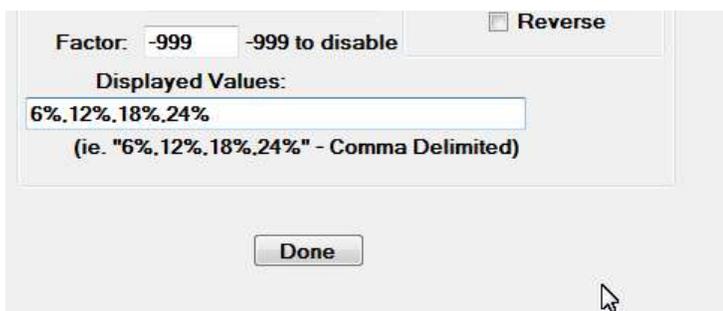
The histogram track has been rethought and improved to be both simple to use, and more versatile, than the original 1.0+ version. The histogram track can be configured into two modes: factor or values mode. A value "-999" in the "Factor:" box (i.e. below figure), enables values mode for the histogram. All other decimal values in the "Factor" box enables factor mode, and the "Displayed Values:" values are disabled (and ignored by the program).

#### Values mode

When the program is started, all three available histogram tracks are, by default, in values mode. The histogram values must be inputted by the geologist / user in the "Displayed Values" area. The values need to be separated by commas (comma delimited). For example, if the user enters the values "6%,12%,18%,24%" (there is no need to put in spaces between values), the histogram track will have five values: none, 6%, 12%, 18%, and 24% (i.e. vales for a porosity histogram). Another example would be to enter: "trace,fair,poor,good,v.good,excellent".

This would translate to a histogram with the values: none, trace, fair, poor, good, v.good, and excellent (i.e. oil show histogram). "None" does not need to be entered as a "Displayed Value", it is added to the histogram by default as a 0 value. When in values mode, the "Scale:" drop-down menu box will be ignored. In values mode the scale of the histogram is always set by the number of values separated by commas plus the "none" value. The "Visible Divisions:" drop-down menu box is still used in values mode for selecting the number of horizontal divisions for the particular histogram track.

The below figure shows a portion of a histogram formatting editor set for values mode, with the Factor box set to -999, and the values of the histogram being set to 6%, 12%, 18%, and 24%.

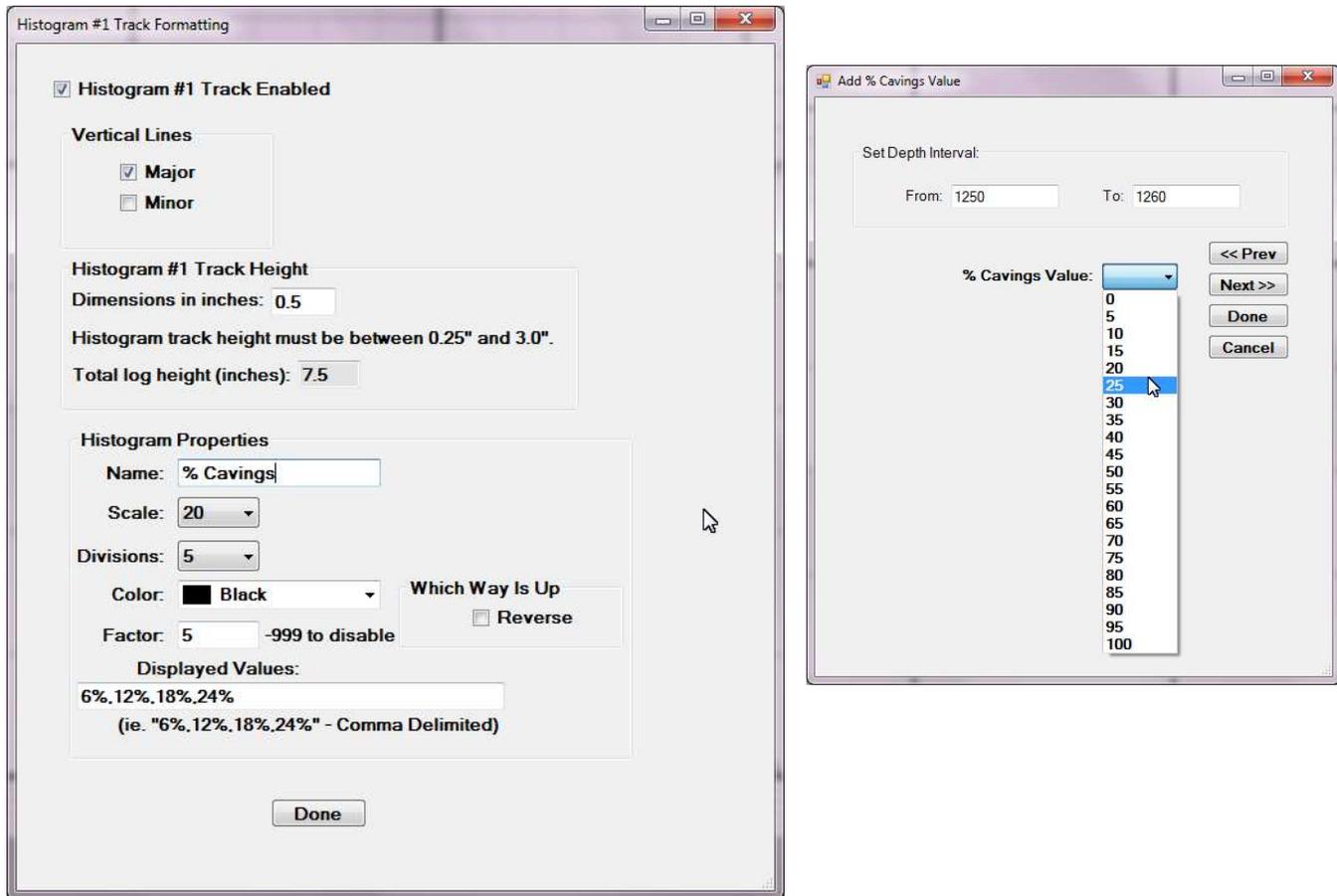


#### Factor mode

The histogram is in "Factor" mode when the "Factor" value is set to any decimal value other than '-999'. When in "Factor" mode, the "Displayed Values:", used in "Values" mode are ignored by the program.

The basic procedure for using the histogram in factor mode is to pick a scale using the "Scale:" drop-down menu. Any scale from 2 through 20 can be selected (in the previous version, the histogram scale was immutable, set at 10). After a scale is selected, the user inputs a "Factor" value, which can be any decimal number. The program computes the histogram values to be selected by the user by multiplying each scale by the factor.

In the below example, the scale is set at 20, with a factor of 5. This means that the histogram values for the % Cavings Histogram will be: 0, 5, 10, 15....90, 95, 100. When the user clicks on the % Cavings histogram track, they will be presented with a drop-down menu with the above just mentioned values as shown below.



### Adding Histogram Data to the Histogram Track

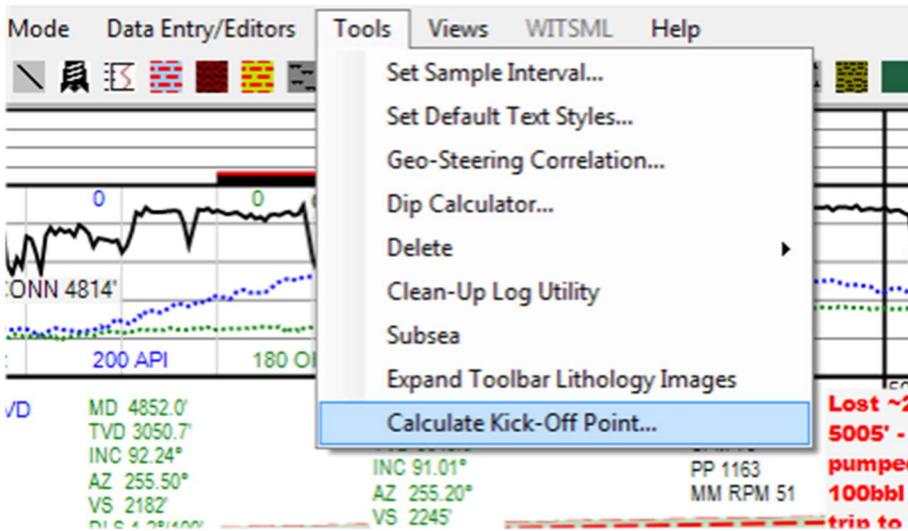
Similar to the sample track, to add data to the histogram track the user may simply click on the histogram track near where they want the data to go. This will open the histogram track editor allowing the user to edit the depth interval and the value of the histogram

#### Click and Drag

A new feature in Horizontal XSection version 3.0+ is the ability to draw the histogram value using the mouse. Simply, hold down the shift key and draw in the interval and value of the histogram. When the left mouse key is released, the histogram editor will open with the depth intervals and histogram values filled in based on the click and drag position.

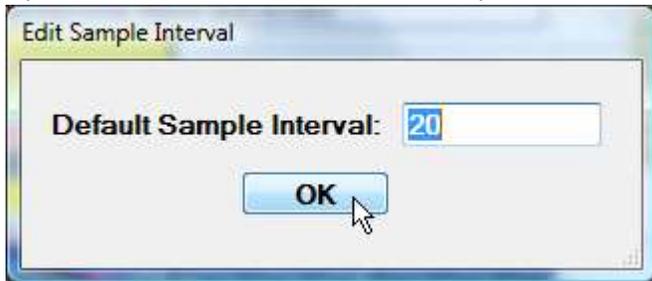
### Tools Menu

The "Tools" menu as the name suggests contain an eclectic set of tools and is accessed from the main menu (see below). Each of these tools and their uses are described below.



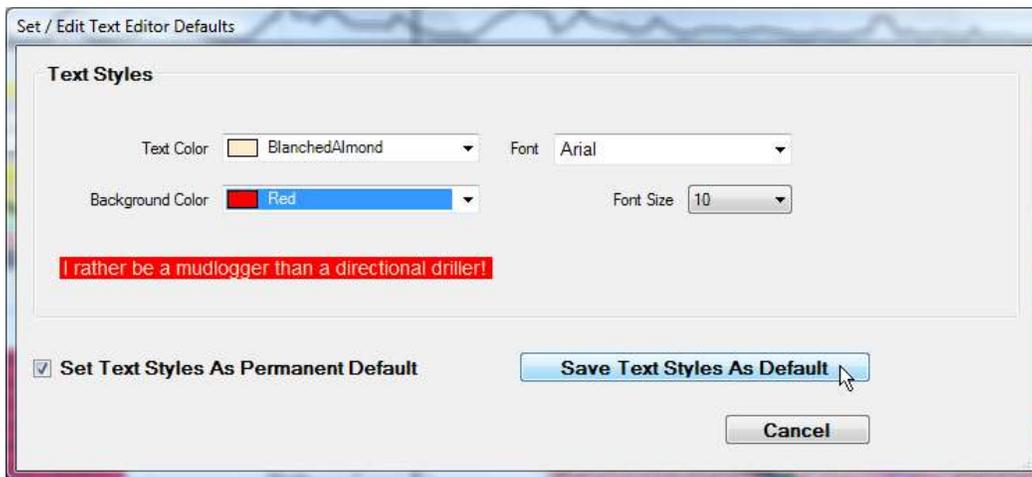
### Set Sample Interval

Opens a window where the default sample interval for both the "Histogram" and "Samples" track can be set.



### Set Default Text Styles

Opens a dialog window where the default text including font size, font color and background color, can be set for either this particular session, or for the program in general.



By checking the "Set Text Styles As Permanent Default", the selected Text Styles will be saved for future sessions of the Horizontal XSection program, otherwise any changes will only be saved for this particular session.

### Delete

The delete feature allows the user to delete particular sections of the log. for example, all the Samples, or all Text Line or Lithology elements. Histogram tracks can quickly be cleared using the delete tool. Be careful though, there is no "Undo" feature for the delete tool!

### Clean-Up Log Utility

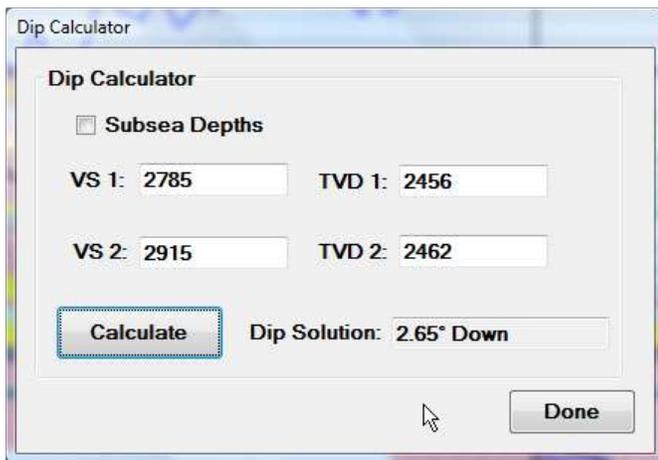
The feature will delete all elements of the log that are partially or wholly out of the viewing area. When a log is shortened, or a TVD scale changed, elements of the log may no longer be visible to the viewer, but still exist in computer memory. This utility will delete these elements, though there is no harm to their existence other than a larger file. Be careful with this utility, for there is no undo feature, and there maybe reasons to keep these elements.

## Dip Calculator

There are two procedures for calculating the dip or apparent dip with the Horizontal XSection software. The first procedure is described in detail in "Chapter 2 - Getting Started", and involves drawing a line between two points and right-clicking the mouse.

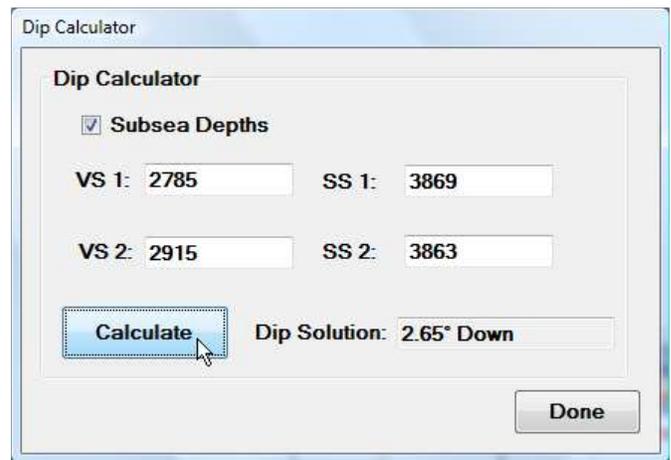
The second procedure involves opening the "Dip Calculator" from the "Tools" menu. The dip calculator, as shown below is a simple calculator that takes two depths (VS1, and VS2) and two TVDs (TVD 1 and TVD 2), and calculates the angle defined by these values. The depths are labeled VS for vertical section, because using VS values obtained from the Horizontal XSection program, will result in the most accurate apparent dip values, assuming that the actual AZ is near the planned VS plane. Only use "Measured Depth" values if you are drilling with a near 90° Inclination, and only if VS values are not obtainable. Check the subsea checkbox to use subsea numbers instead of TVD numbers. The program will automatically detect the dip direction (i.e. "Up" or "Down").

### Using TVD Values



The screenshot shows the "Dip Calculator" window with the "Subsea Depths" checkbox unchecked. The input fields are: VS 1: 2785, TVD 1: 2456, VS 2: 2915, and TVD 2: 2462. The "Calculate" button is highlighted with a dashed border. The "Dip Solution" field displays "2.65° Down". A "Done" button is located at the bottom right.

### Using Subsea Values



The screenshot shows the "Dip Calculator" window with the "Subsea Depths" checkbox checked. The input fields are: VS 1: 2785, SS 1: 3869, VS 2: 2915, and SS 2: 3863. The "Calculate" button is highlighted with a dashed border. The "Dip Solution" field displays "2.65° Down". A "Done" button is located at the bottom right.

The "Dip Calculator" can remain open while working on other aspects of your log, and is set to always be the top-most window.

## Subsea

When the "Subsea" feature in the tool menu is enabled, the TVD scale on the cross-section will be replaced with Subsea values. Moreover, the TVD value in the status label at the bottom of the window that displays the survey data, will be replaced with subsea values (See red circles in below example). This feature can be toggled on and off, as desired, so that both TVD and Subsea values are easily accessible.

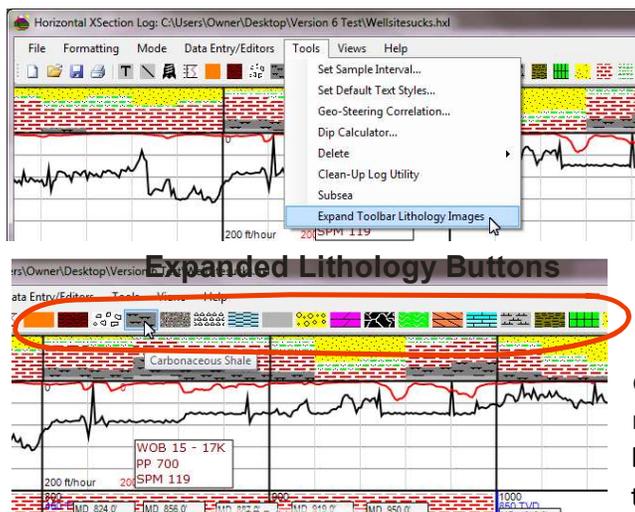


### Geo-Steering Correlation Tool

This tool will open "Geo-Steering Correlation" instrument. See "Chapter 11 "(Geo-Steering Correlation Tool) for more information.

### Expand Toolbar Lithology Images Menu Item

The expand toolbar lithology images menu item found in the "Tools" drop down menu (see below), expands the lithology buttons on the toolbar to exhibit the lithology patterns exactly as they will appear on the log. A wide monitor is helpful for this feature.



### Calculate Kick-Off Point Calculator

The "Calculate Kick-Off Point..." menu item, as the name suggests, opens a build-in calculator that allows the user to determine the Measured Depth kick-off point (KOP). The calculator, based on the desired build dogleg, KOP inclination, landing point inclination and landing point TVD, will determine the KOP as a measured depth value, if the KOP is in a vertical borehole, or the KOP as a TVD, in an inclined or deviated borehole. Besides the MD Kick-off point, the calculator will determine the 'Build Length' as a measured depth value, the measured depth landing point and the vertical section at the landing point away from the KOP. If the KOP is in a deviated well, the calculator will not calculate the MD landing point, and the KOP will be a TVD value. It will still calculate the Build length, so if the MD at the TVD kick-off point is known, the MD landing point will be easy to calculate ( $MD \text{ Landing Point} = MD \text{ KOP} + \text{Build Length}$ ).

### Inputs

Dogleg / 100':

KOP Inclination:

Landing Pt. Inclination:

Landing Point TVD:

### Output

Build Length (MD): 818.2

MD Kick-off Point: 2724.13

MD Landing Point\*: 3542.31

\*Only Applicable if KOP Inclination = 0!

VS at Landing Point: 520.9

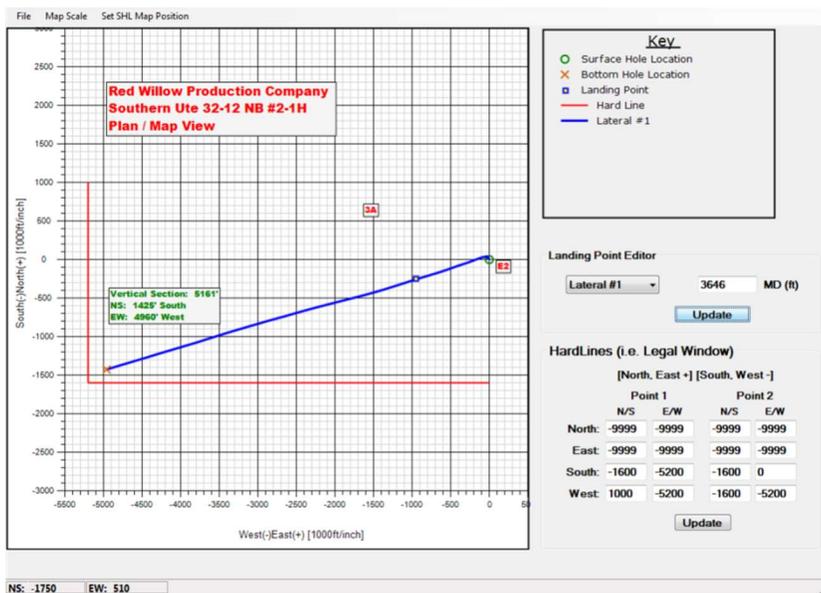
## Views Menu

There are two sub menus under the "Views Menu": "Plan Or Map View" and the "TVD vs. Vertical Section" menus.

## Plan or Map View

Clicking the "Plan or Map" menu item will open a new window with a map view of all the laterals, including surface-hole location and bottom-hole location. The user can then

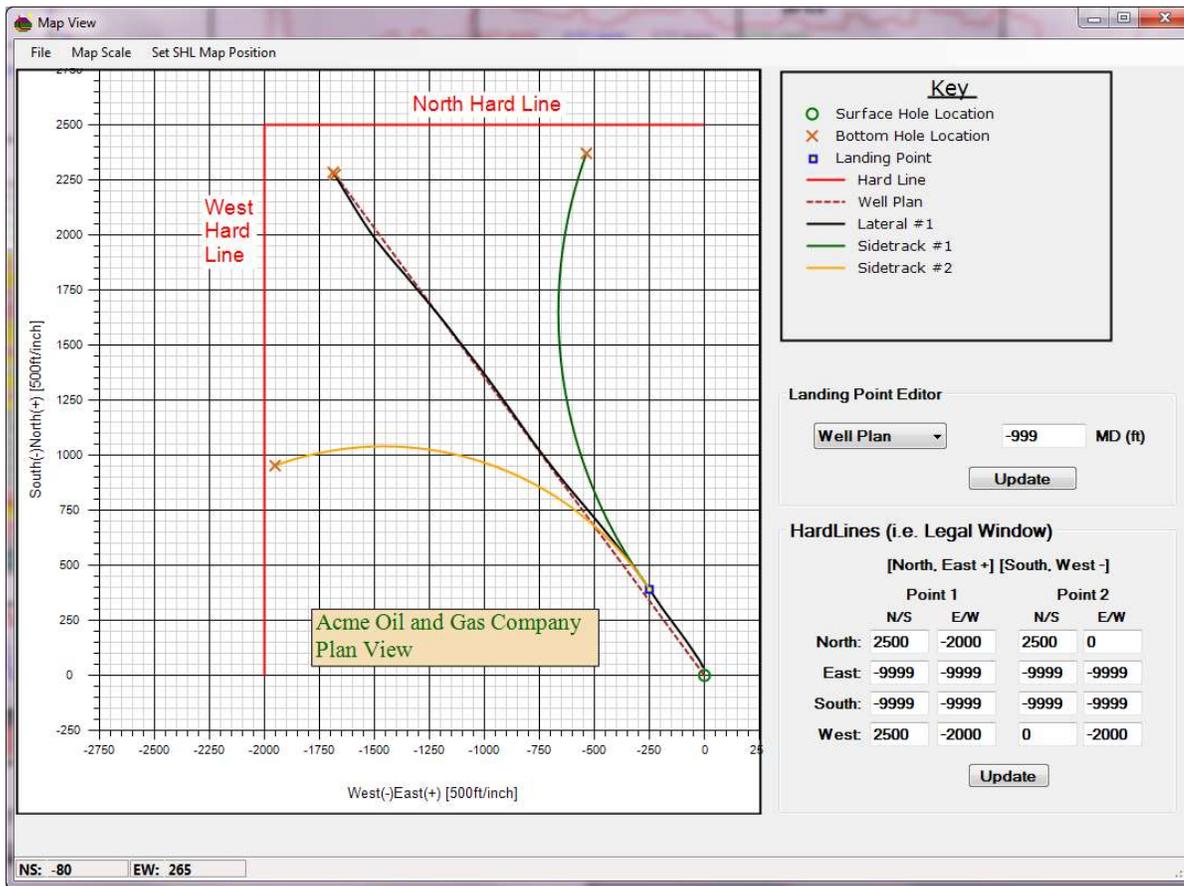
add landing points, hard lines, and text (screen shot example below).



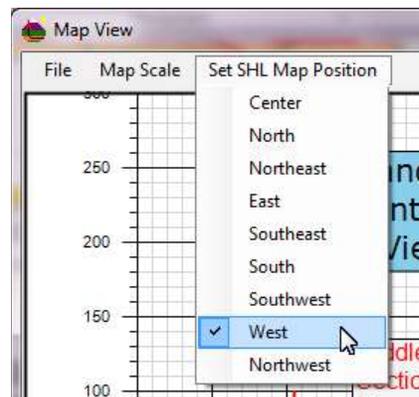
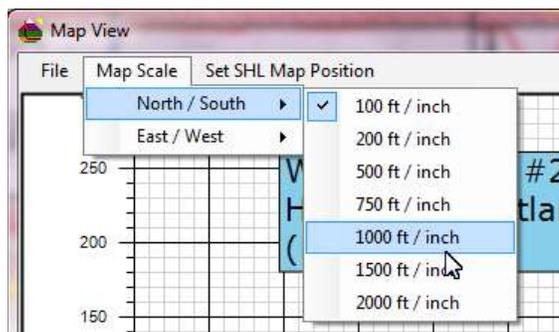
Up to four separate hard lines can be plotted corresponding to the four directions. Hard lines are drawn by the computer in red and are set according to the wells surface hole location. For example the "North" hard line is drawn below from a point 2500' north and 2000' west of the SHL to a point 2500' north and 0' west of the SHL. Enter -9999 for no hard line to be drawn.

Each lateral can have one landing point, which is usually the measured depth location where the build ends. To enter a landing point using the "Landing Point Editor", select the lateral of interest from the drop-down list, and enter the measured depth where the landing occurred.

The program will then plot a blue and yellow rectangle at the appropriate map view location. Enter "-999" and the program will not plot a landing point symbol.



Map scales for both the north/south and east/west axis can be adjusted by using the “map Scale” drop down menu items:

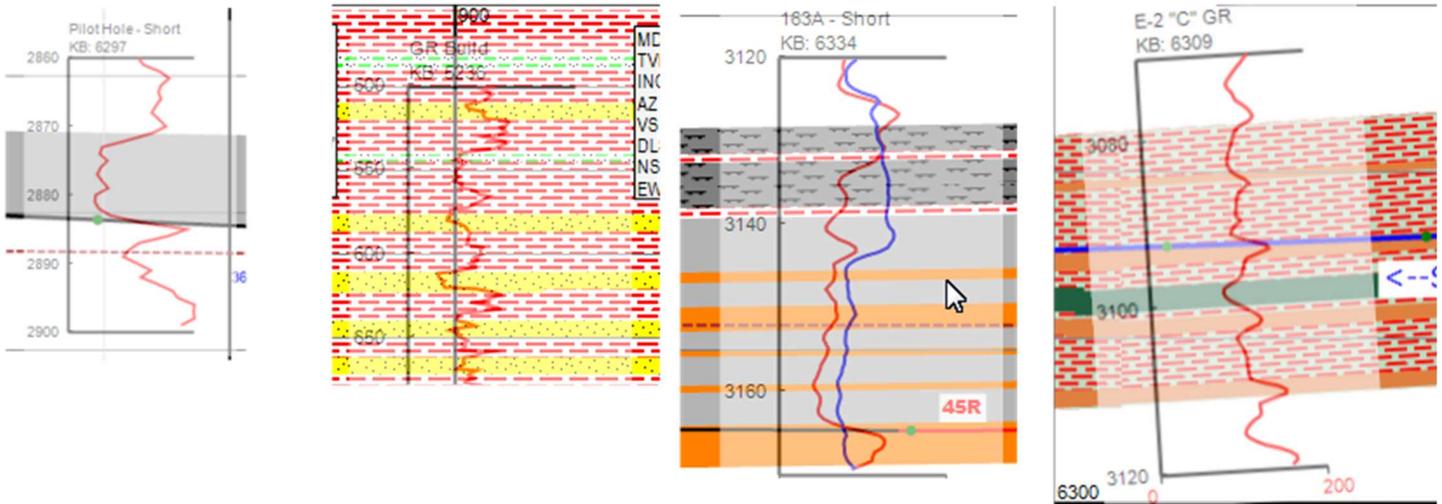


Similarly, the SHL map position is automatically set by the computer based on the well plan or lateral #1 direction, but can also be manually set using the “Set SHL Map Position” drop-down menu.

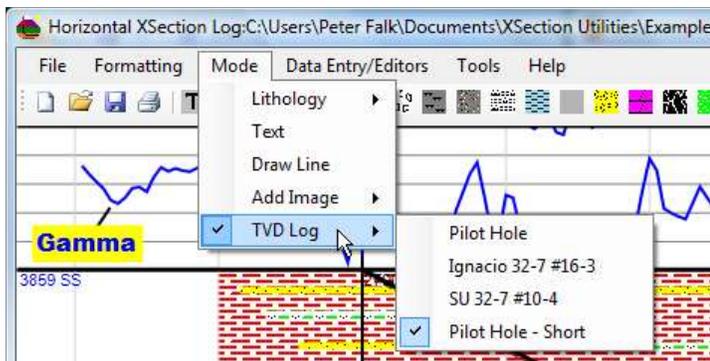
## TVD Logs

The Horizontal XSection Log program allows the user to add logs (usually gamma, but can be any log type) to the cross-section, to be used as a correlation tool. These logs can be offset logs, the pilot hole log, or the LWD log (corrected for TVD), from the build section of the lateral. There is no limit to the number of TVD logs that can be added to your log. Each TVD log can hold one or two curves, and can be rotated on the log to match apparent dip. Moreover, the log can be made semi-transparent (called opacity), so that the other features of the log can be seen underneath the TVD Log.

*Examples of TVD logs set to 50% opacity (opacity is the opposite of transparency)*



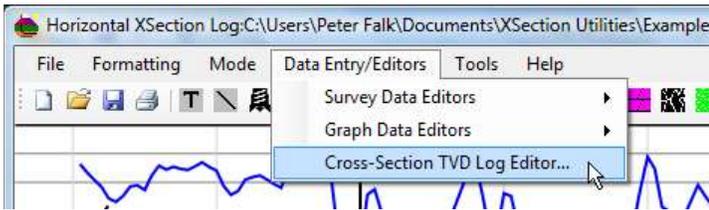
There are two steps involved in the process of adding a log curve to your cross-section. The first step is to upload the log, or logs to memory. When a log has been uploaded, it will be displayed as a menu item under "TVD Log" in the "Mode Menu" (Mode->TVD Log ->'list of logs').



The above example shows four logs that are in memory. Once a log is in memory, it will be saved with the file when the file is saved. The second step is to select a log from the menu, and then add the selected log to the cross-section track.

## Loading a Log

The process of loading a log is simple, and similar to loading curves into the graph tracks. The first step is to open the "Cross-Section TVD Log Editor..." by selecting this option from the "Data Entry/Editors" menu.



This will open the log editing window (see below). This window will display the list of loaded logs on the right and the corresponding information for each log on the left, on the far right will be a graphical display of the loaded log.

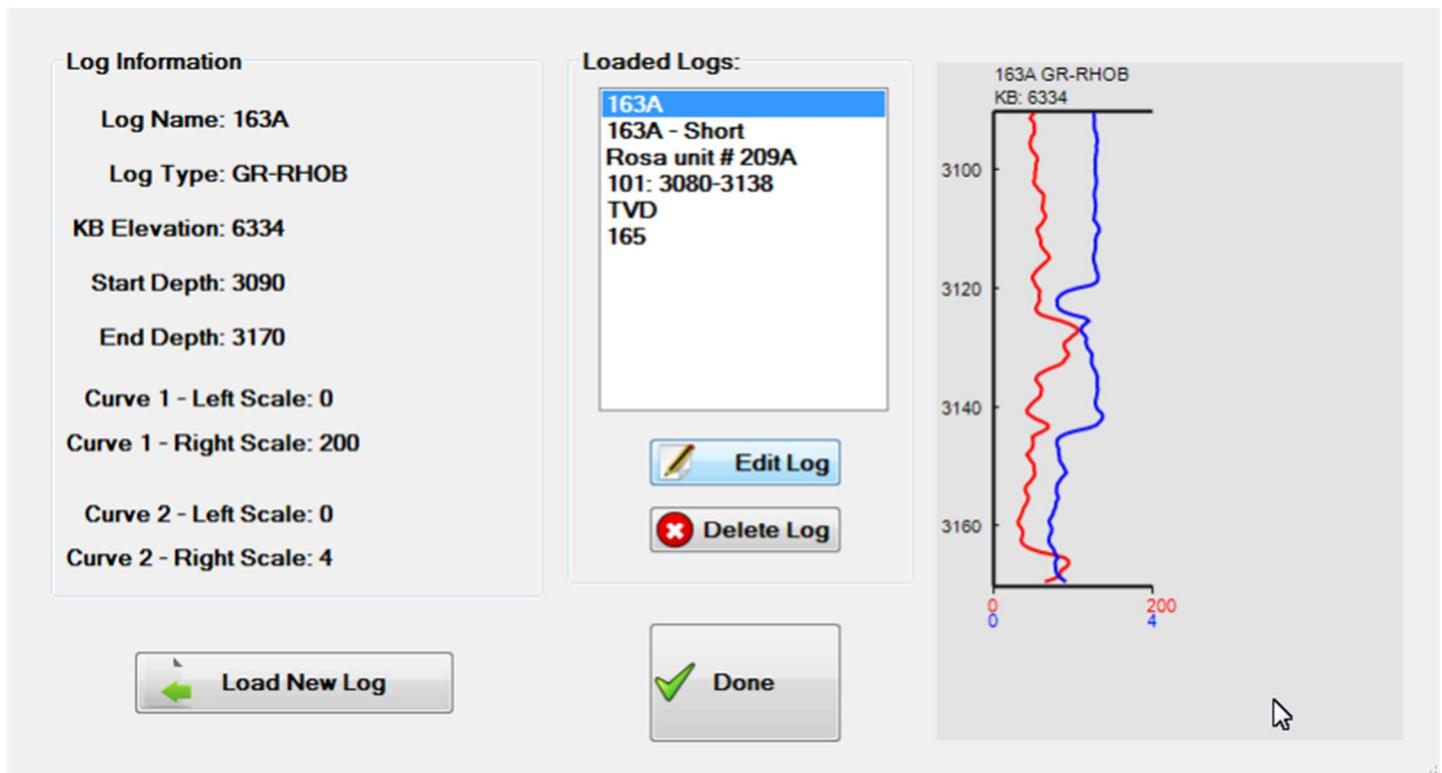
**Note, the log when added to the cross-section may look different than in the "Log Editing Window" because it will automatically be scaled to the Cross-Section Track's TVD Scale.**

The second step is to click the "Load New Log" button. After clicking this button the user will be prompted to select the log to be loaded. The default log file type is a text files (\*.txt), but Comma delimited files (\*.csv) as well as LAS (2.0 Standard only, no wrap) files (\*.las) can also be loaded. Once a log has been loaded, the final step is to edit the log in the "Import Log Data and Log Information" window (see below, next page, left figure). It is here that the log depths are selected, the log is given a name, the log type is entered (optional), and the KB elevation for the log is entered (optional).

**Note: the default KB value of -999, which tells the program that no KB elevation has been entered.**

The advantage of entering a KB elevation, is that it is displayed with the log. Moreover, it allows the user the ability to display the log in subsea depths rather than TVD.

### Log Editing Window



### Deleting a Log

To delete a log simply select the log from the list in the "Cross-Section TVD Log Editor" and click the "Delete" button.

## Editing a Log

A new feature with Horizontal XSection version 3.0+, gives the user the ability to edit logs after they have been loaded into the "Cross-Section TVD Log" editor. Simply click on the "Edit Log" button (see above figure) to open the "Edit TVD Log Information" window (see below – next page, right figure). Though actual log numeric values data cannot be added or edited, the "Edit TVD Log Information" window allows the user to edit the log name, scales, start and end depth(s), KB elevation, and log type values. When done adding, deleting or editing TVD logs, click the "Done" button to exit the "TVD Log Editor" window. The new and or edited logs are listed in the Mode->TVD Log menu at the top of the program window.

## Import Log Data and Log Information Window Edit TVD Log Information Window

Select Columns and Enter Log Information:

File: C:\Users\Owner\Desktop\ROP.txt

Enter Log Information:

Start Depth: 446      Log Name: Pilot Hole  
End Depth: 7833      KB Elevation: -999  
Use -999 if not entering a KB elevation

Log Type (i.e. Gamma):      (Optional)

Curve Data

Curve 2	Curve 1	Depths (TVD)
Column: None	Column: Column 1	Column: Column 1
Left Scale: 0	Left Scale: 0	First Depth: 446
Right Scale: 200	Right Scale: 200	Last Depth: 7833

Edit TVD Log Information

Enter Log Information:

Start Depth: 3090      Log Name: 163A  
End Depth: 3170      KB Elevation: 6334  
Use -999 if not entering a KB elevation

Log Type (i.e. Gamma): GR-RHOB      (Optional)

Curve Data

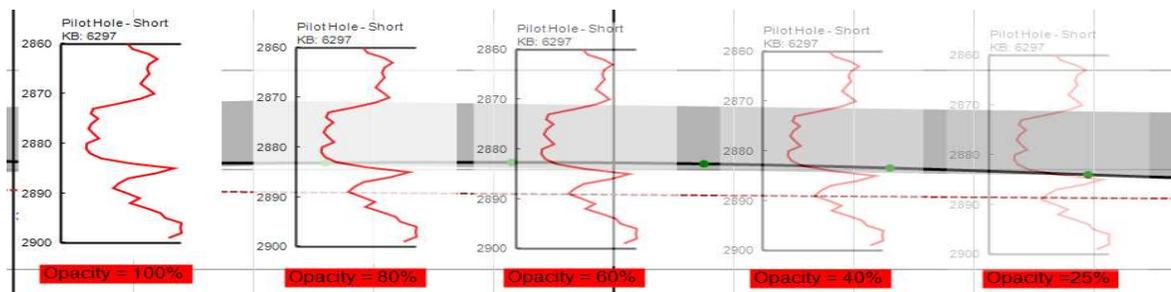
Curve 2	Curve 1	Depths (TVD)
Column:		
Left Scale: 0	Left Scale: 0	
Right Scale: 4	Right Scale: 200	

## Adding a Log to the Cross-Section

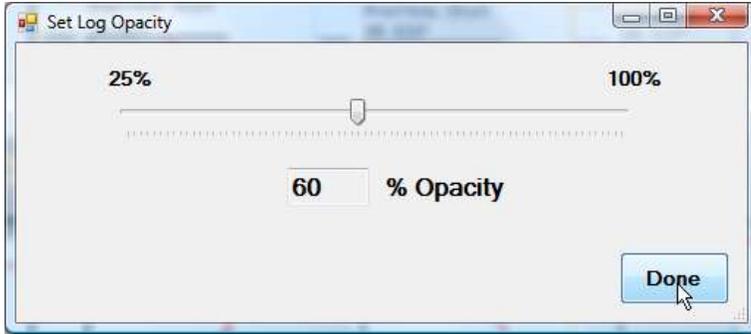
To add a log to the cross-section, the first step is to be in the "TVD Log" mode. As mentioned in previous chapters, there are presently five modes (possibly more in later versions), of which "TVD Log" is one. In this mode, logs may be added to the cross-section and / or moved, and their display edited. There are two ways to select "TVD Log" mode. The first is to select a log from the menu list (Mode->TVD Log->'Select a log') as described above. This will automatically change the program into "TVD Log" mode. The other method is to click the  icon on the toolbar. This too will switch the program into TVD Log mode. Once in log mode, click anywhere on the cross-section to place the selected log type onto the log To 'Move', 'Delete', change 'Opacity' or toggle 'Subsea' option, move the mouse over the TVD log (an orange border will appear) and right-click the mouse to open the pop-up menu.

## Setting Log Opacity

Log Opacity refers to the transparent state of the TVD Logs that have been added to the cross-section. A TVD log with an opacity value of 100% is completely opaque. Log opacity values are set by the user and range from 25% to 100%. The example below shows the same TVD log with varying opacity values.



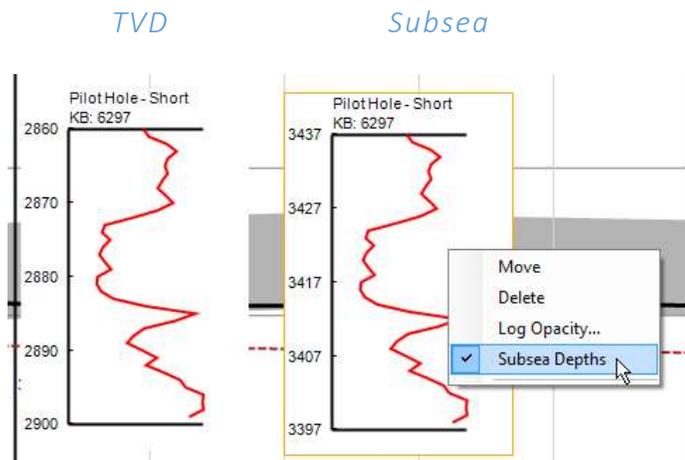
To set the opacity value simply move the mouse over the log in question until the orange bounding rectangle appears, right-click and choose the "Log Opacity..." menu item to open the "Set Log Opacity" window.



Simply set the slide to the desired value and click the "Done" button. When TVD logs are first imported the default opacity value is 100%, or completely opaque.

### Log Subsea

Just as with the cross-section track, individual TVD logs can be set to display subsea depths (instead of TVD) along the depth axis. Simply right-click and select subsea to have the log display subsea depths.



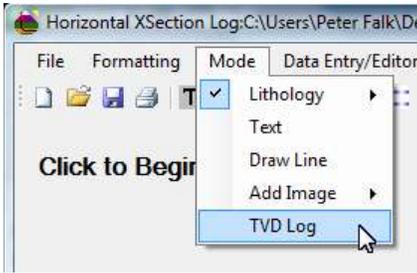
### Missing TVD Logs

File Name	Size
Example Header File.hdf	335
Example Log 1	760
Example Log 2	691
tiff to de	2,649

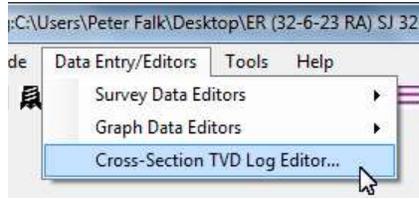
Hover tooltip for Example Log 2:  
Type: XSection Program  
Size: 690 KB  
Date modified: 4/16/2010 6:12 PM

If you open a file by double clicking on a log file (i.e see above), rather than using the "File->Open" menu item, you will find that the "TVD Log" list will be empty, even if the double-clicked file (\*.hxl) contains saved TVD logs.

*Empty "TVD Log" List*

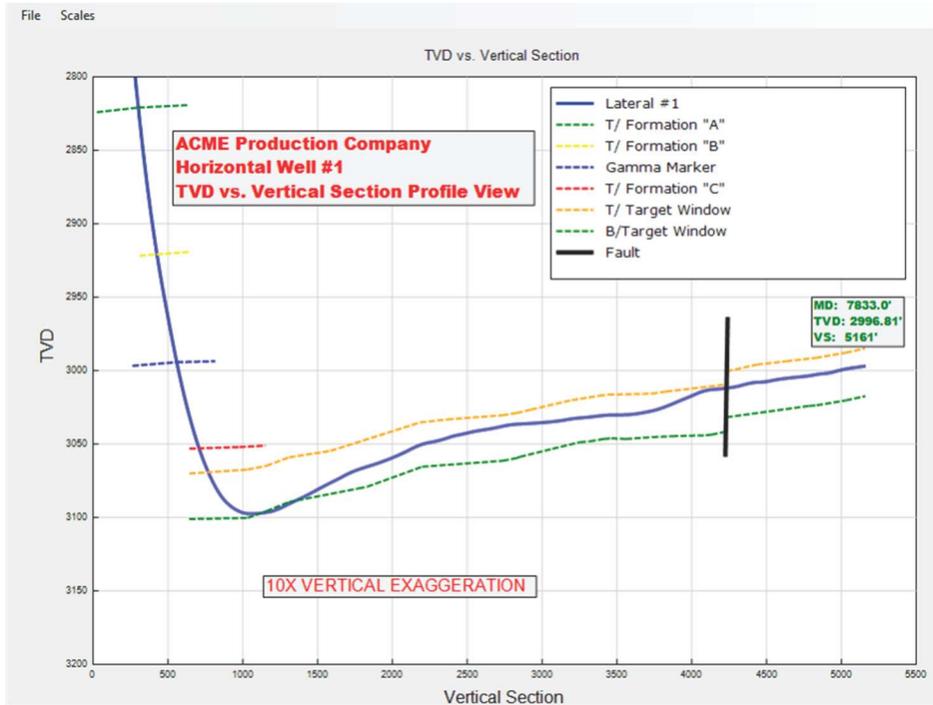


*Open and Close the "Cross-Section TVD Log Editor"*



To rectify the situation, open and close the "Cross-Section TVD Log Editor" and the list will appear.

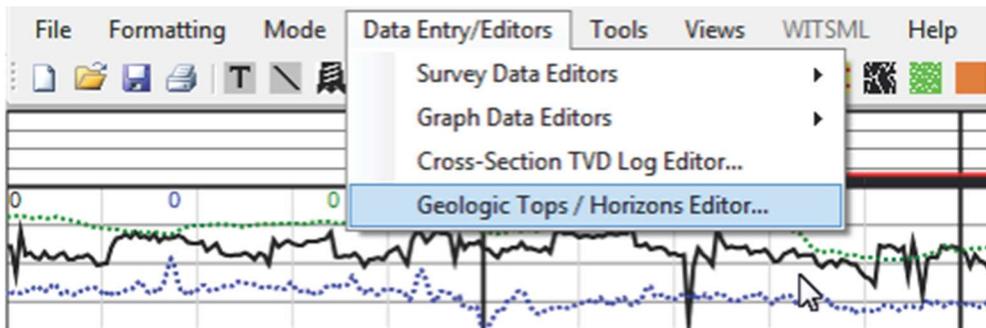
Geo-Horizons - Tops, Faults and other 2-dimesional Surfaces



Geo-horizons allow the program to delineate planes of importance that can be projected on to the **TVD vs Vertical Section** view. In the example at left, the formation tops (and bottoms) and the fault are all projected from the mudlog to the TVD vs. Vertical Section using the geo-horizon feature. Any two-dimensional feature can be added, like porosity zones, oil/water contact, member tops, faults and or fractures.

Geo-horizon Editor

The first step in creating Geohorizons is to open the geo-horizon editor from the “Geologic Tops / Horizons” sub-menu. This will open up the geo-horizon editor.



Use the “Add” button to create a new Geo-horizon, then use the “Change Top / Horizon Name” to give the new Geo-horizon a name. The “Line Attributes” allows the user to edit the Geo-horizon for ‘Line Style’, ‘Line Width’ and ‘Line

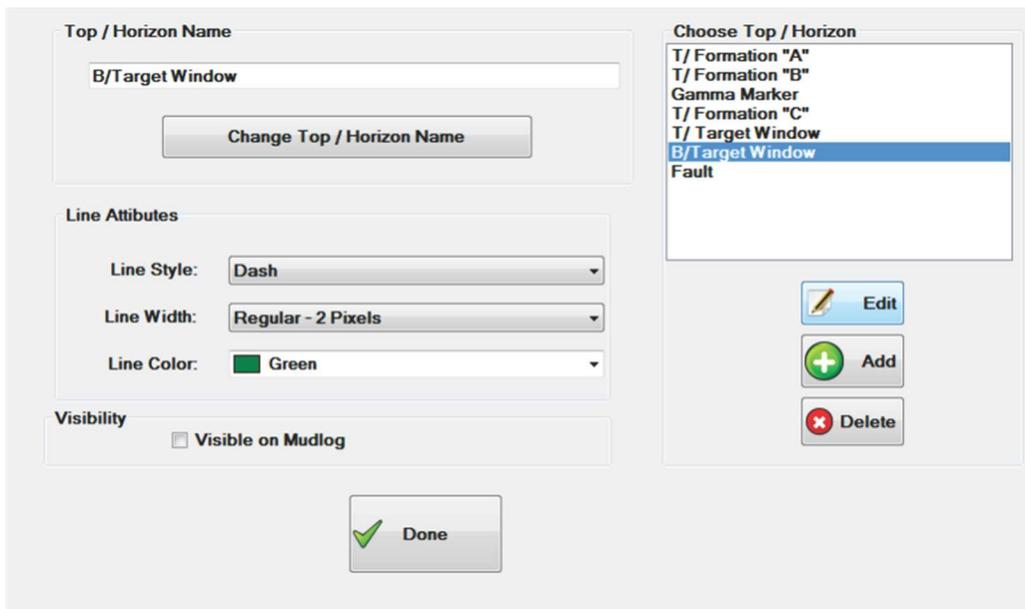
Color, much as in previous editors for the graphs and survey data. The visibility check box allows the user to toggle (visible or not visible) whether the Geo-horizon is displayed on the mudlog cross-section track. The Geo-horizon is always displayed on the “TVD vs. Vertical Section” view.

Geo-horizon Data

Geo-horizon data consists of a list of Measured Depth (MD) and true vertical depth (TVD) values. Though the easiest way to enter a Geo-horizon is on the mudlog directly (see below), Geo-horizon data can be entered using the “Edit” feature.

Projecting Geo-horizon Data onto the “TVD vs. Vertical Section” View

To display a Geo-horizon onto the “TVD vs. Vertical Section” view, the program must project the geo-horizon data from the mudlog cross-section track to the “TVD vs Vertical Section” View. This is done my converting the measured depth

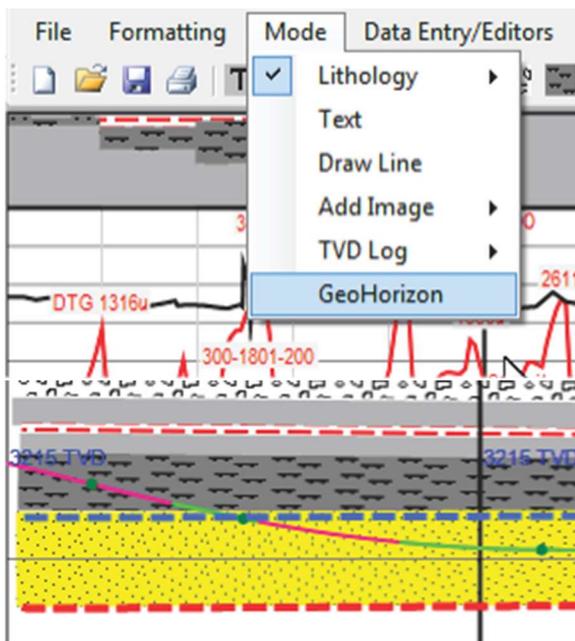


values in the Geo-horizon data to a corresponding VS values by culling the survey data and converting each MD value to a corresponding Vertical Section (VS) value. This can only be done if there is a corresponding VS value for every MD value of a Geo-horizon. If there is no corresponding VS value, the Geo-horizon will not draw that particular point on the TVD vs. Vertical Section view. For this reason, Geo-horizon points that fall outside the survey

data (whether it be a well plan, lateral or sidetrack) will not be drawn. Often times, if you have multiple survey data curves on your log, for example a well plan and a lateral, there may be more than one VS value for a corresponding MD value. In this case the program will use whichever VS value comes last in the list. If your first survey curves are a well plan a lateral #1 and a lateral #2, the projection for a particular MD value will first look at the well plan survey data, then the lateral #1 survey data and finally the lateral 2 survey data. If they all have data for a particular MD, the lateral #2 survey data will be used by the software.

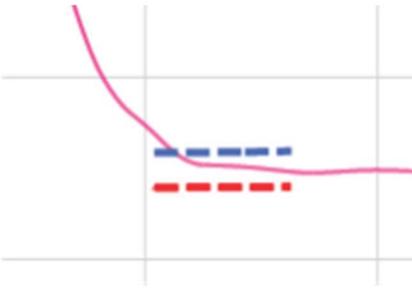
### Adding Geo-horizon Data to the Mudlog

The first step to adding Geo-horizon data is to switch to “Geo-Horizon” mode using the Mode menu.

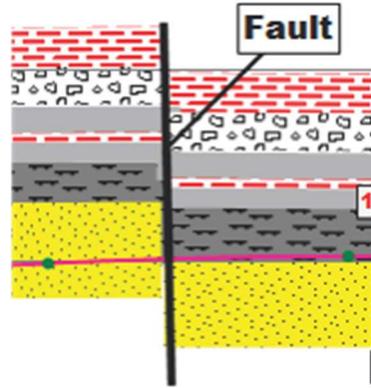


This will open a list of Geohorizons that the user has created using the Geo-horizon editor. Select the appropriate Geo-horizon and then click done. The cursor will appear as a cross-hair. Move the cursor to where you want the next Geo-horizon point to be a left-click the mouse. This will draw the Geo-horizon from the last point to the new point. Use the Escape (Esc) key to delete the last point.

In the above example, the sandstone ‘target zone’ is delineated by a dashed blue Geo-horizon layer (top) and a dashed red Geo-horizon layer (bottom). The figure below shows how these layers will be projected onto the “TVD vs. Vertical Section” view.



The Geo-horizon layer must be drawn in a forward, down-hole or increasing measured depth direction. Each new point must have a higher measured depth value than the previous Geo-horizon point. A Geo-horizon point that has a lower measured depth value will not be recorded by the program. This means that faults must be drilled at a slight angle as shown in the example below with the first point at a lower MD than the second point.



### Edit Feature

	MD	TVD
▶	3304	3070
	3699.5835	3067.29175
	3825.8335	3064.79175
	3978.3335	3058.95825
	4254.583	3054.58325
	4442.5	3050.83325
	4855	3035.16675
	5035.667	3033.16675
	5404.333	3030.33325
	5498.667	3028.83325
	5593.667	3026.5
	5869	3020
	6049.1665	3017.08325
	6110.8335	3016.25
	6225.8335	3016.04175
	6402.0835	3015.625
	6500.4165	3014.16675
	6597.5	3013.75
	6900.8335	3009.375
	6903.75	3000.41675
	7104.5835	2995.83325
	7301.25	2993.54175
	7499.1665	2991.25
	7699.5835	2987.70825
	7828.3335	2984.79175
*		

Datum Column = T/ Target Window

**Add/Delete Data**

Insert Row

Datum Value:

Delete Row

**MD Column**

Check Sorting

**Datum Column**

Delete Rows

With  Value

Replace

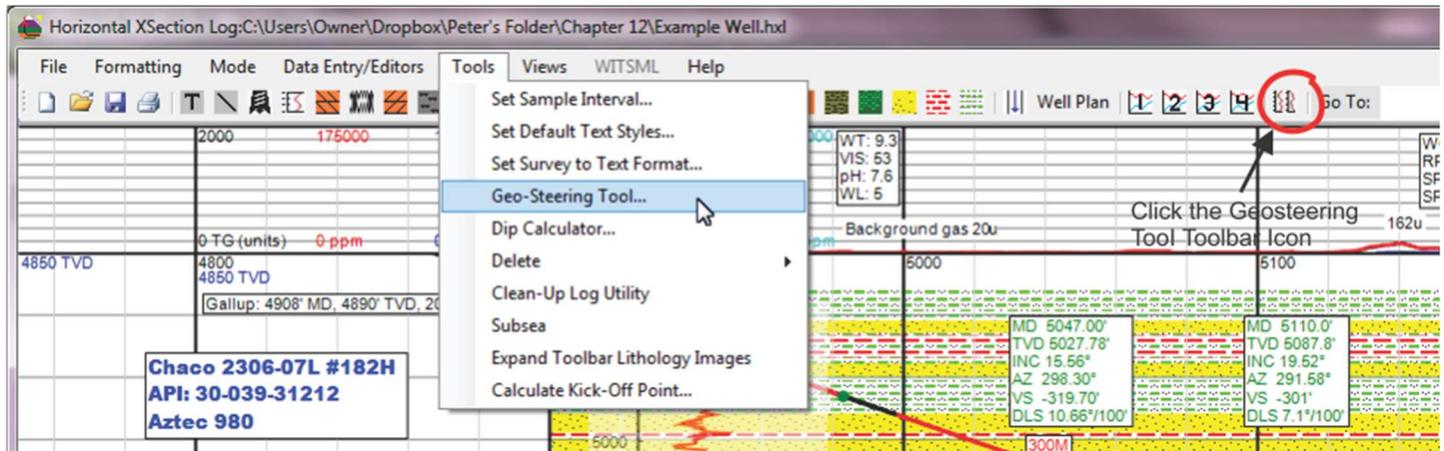
With

All Done

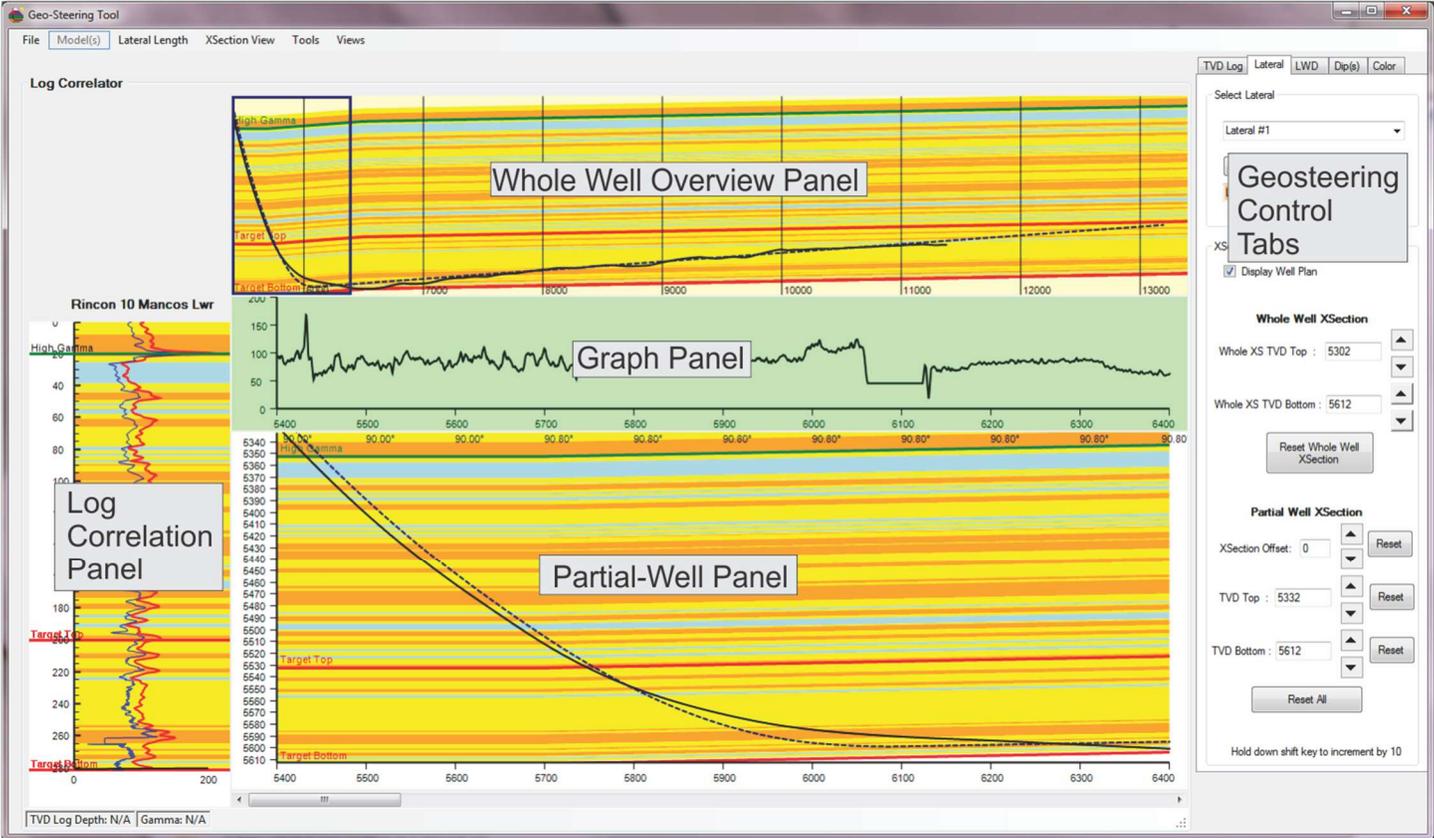
Data can be edited by opening the “Edit” window in the Geo-horizon editor. This is done by selecting the Geo-horizon in question and clicking the ‘Edit’ Button. The Geo-horizon data editor is similar to the editor for the graph curves, and consists of two columns, one for the MD value and one for the TVD value.

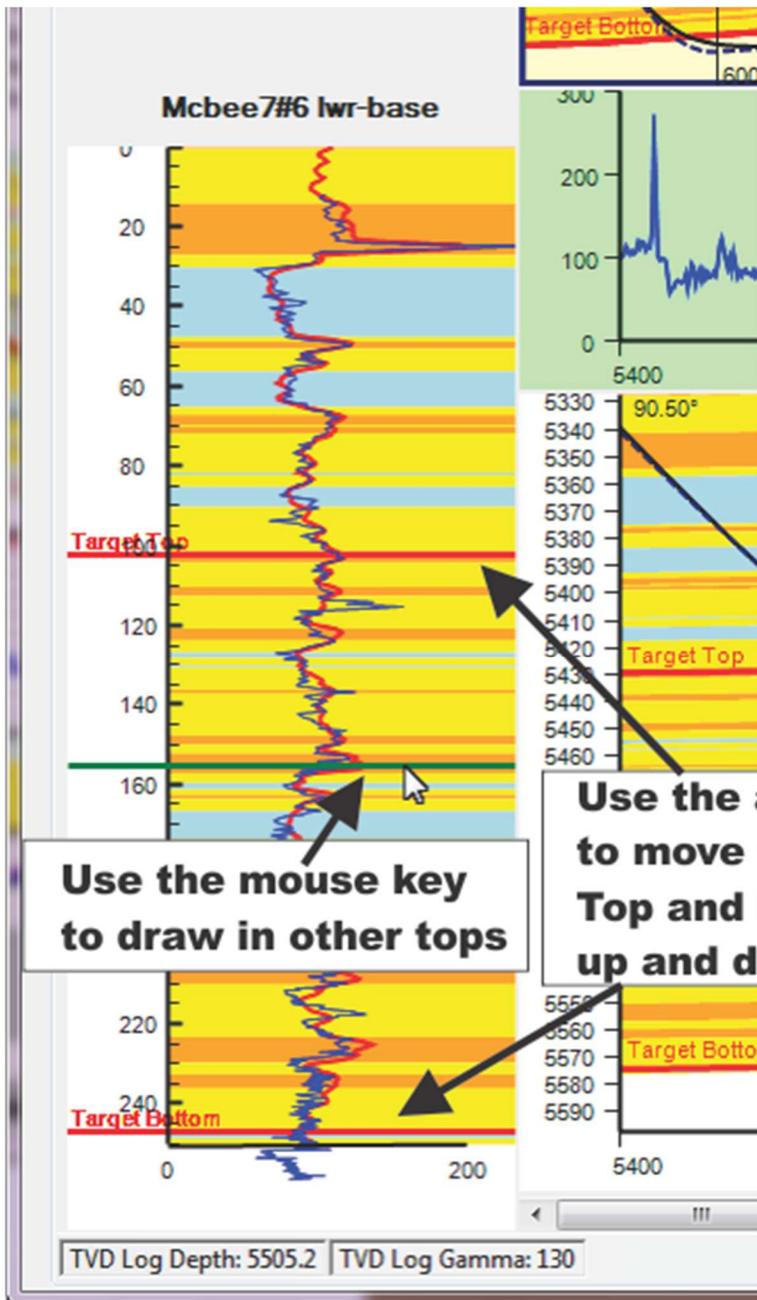
## Introduction

The Horizontal XSection Pro version comes with an integrated Geosteering tool that works in conjunction with the main part of the Horizontal XSection Program. The geosteering tool takes the TVD logs created in the main portion of the program (See Chapter 10 – TVD logs in the Cross-section) that the user can use as models for correlating the LWD gamma with an offset well or pilot-hole logs. Tops and gamma markers can be added to the geosteering model and then within the tool, Geohorizons can be created that are transferred to the main logging program. The Geosteering Tool can be accessed through either the Menu Item Tools->Geo-Steering Tool..., or by clicking the Geosteering toolbar icon shown circled in red below.



Once the Geosteering tool is opened, there are a set of tabs on the right-hand side of the screen that allow the user to access the different controls for correlation. The tabs are labeled "TVD Log", "Lateral", "LWD" "Dip(s)" and "Color".





The visual part of the geosteering tool is made up of 4 panels. The left-side panel contains the “Log Correlation Panel”. This is where a model gamma curve is loaded and used to match the TVD and LWD gamma to determine formation dips. The Partial-Well Panel shows a user-determined footage interval, the default being 1000’. The middle panel is “Graph Panel” shows the MD gamma for the Partial-Well Panel Measured Depths. And finally, the top “Whole-well Overview Panel” shows the whole well with the Partial-Well Panel footage delineated by a blue box.

The rest of this chapter goes through a step by step process of how to use the geosteering tool both for landing and staying within the target zone.

### TVD Logs and the TVD Log Tab

When the Geosteering Tool window is opened, the TVD Logs that had been loaded into the programs memory using the Cross-Section TVD Editor (described in chapter 10) will be available to the user in the

“TVD Log” tab. Select the TVD log for the model from the “Select TVD Log” drop down list, at the top of the “TVD Log” tab. Once selected, click the Load Selected TVD Log button, and the selected log will appear on the left side of the screen.

### Color-Coding

The program will automatically color-code the log depending on the settings of the Low and High Gamma Values. To change the gamma values use the arrow keys to either move up or move down the values. Any section of the log with a value below the Low Gamma value will be color-coded blue, while any values higher than the High-gamma value will be color-coded orange. Values in-between the two values will be color-coded yellow.

### Target Top and Bottom

Target top and bottom are shown in the TVD log as red lines with their default location at the top and the bottom respectively, of the TVD log. To move the target top and bottom lines simply use the up and down keys in the TVD tab.

**Note: Depress the Shift key while clicking the arrow-keys to increment by values of 10.**

When the top and bottom targets are moved in the TVD log, the associated top and bottom target lines are also moved in the partial and whole log panels. The target top and bottom lines are always annotated with the "Target Top" and Target Bottom" respectively directly above the lines in the TVD log panel as well as the partial and whole well panels, and are always drawn with a thick red line.

### Adding Other Tops

Adding other tops is as easy as depressing and holding down the left-mouse button while moving the mouse up or down to exactly place the top. When the mouse button is released a window will open that allows the user to name and choose the color of the top.

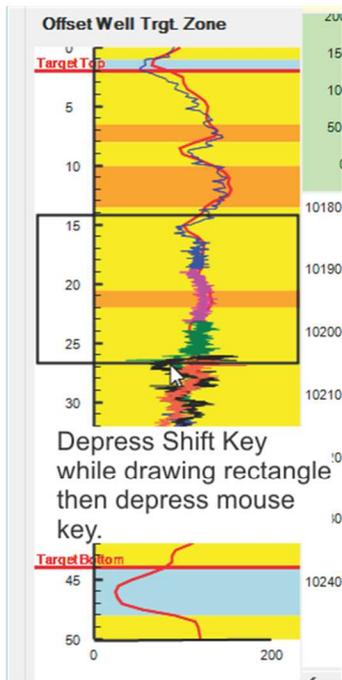
### Reference Depth Offset

The reference Depth Offset moves the footage scale bar on the left-hand side of the TVD log reference scale. The default is to have the 0 depth at the top of the TVD log.

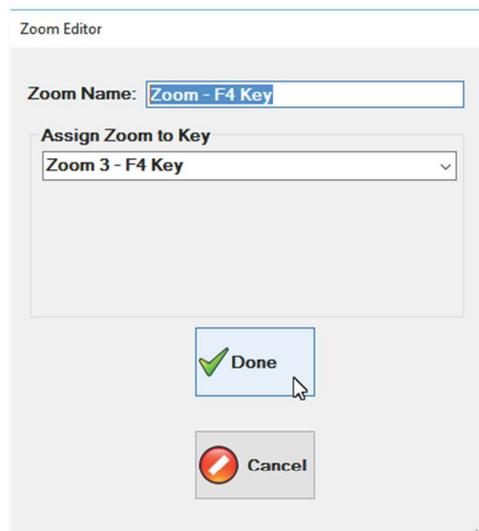
### Zooming

The log-correlation panel that holds the offset log model can be zoomed in to show a more detailed view of your correlation. Up to three different zoomed panel views can be saved. To create a zoomed in log-correlation panel move the mouse over the panel and depress the shift key. This will create a black rectangle that will delimit the new view. The new view can be saved to the F2, F3, F4 and F5 buttons. Use the Tools->Clear Zoom Keys to reset all the Zoom keys.

#### Step 1

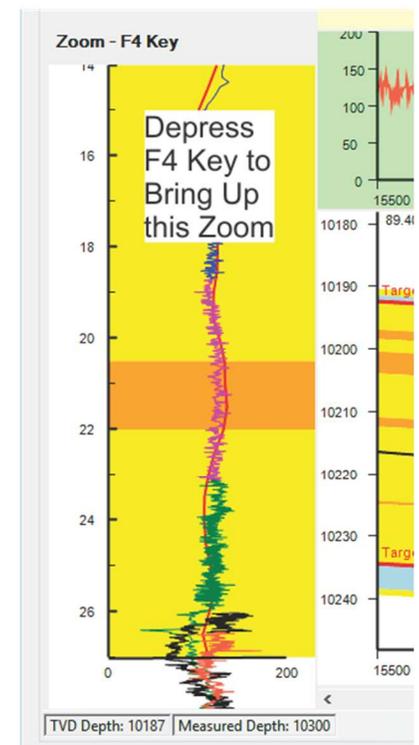


#### Step 2



Select F2-F5 Key

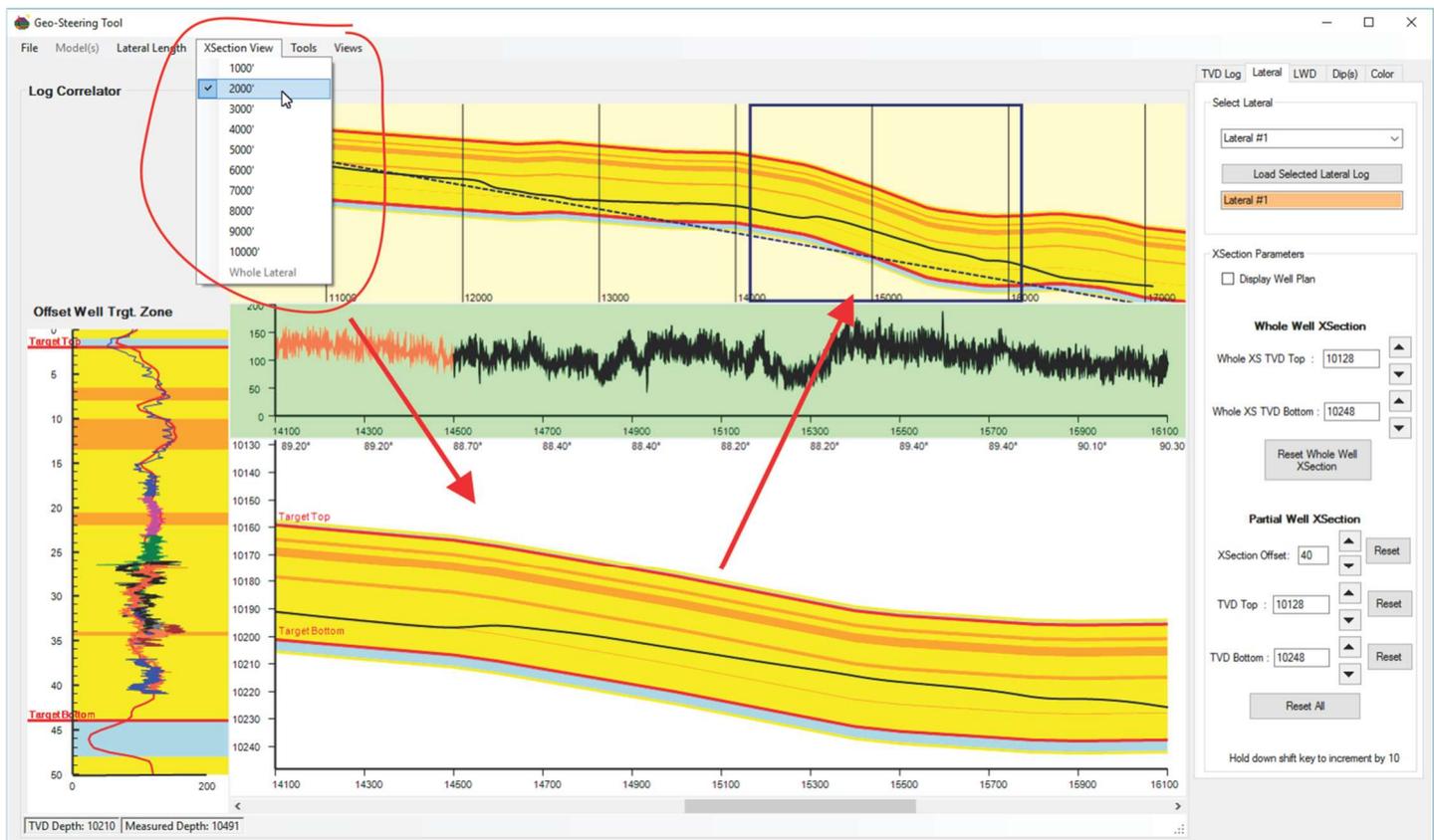
#### Step 3



### Lateral Tab

The lateral tab is where the user chooses which lateral to use in the modeling. In the XSection Parameters portion, use the up and down arrow keys to position the cross-section by moving the TVD Top and TVD bottom values up and down. The Partial Well-XSection also has an offset value to move the cross-section up and down. Each parameter has a reset

button to return to the beginning values. The XSection View drop down menu controls how much MD footage is shown on the partial well panel.

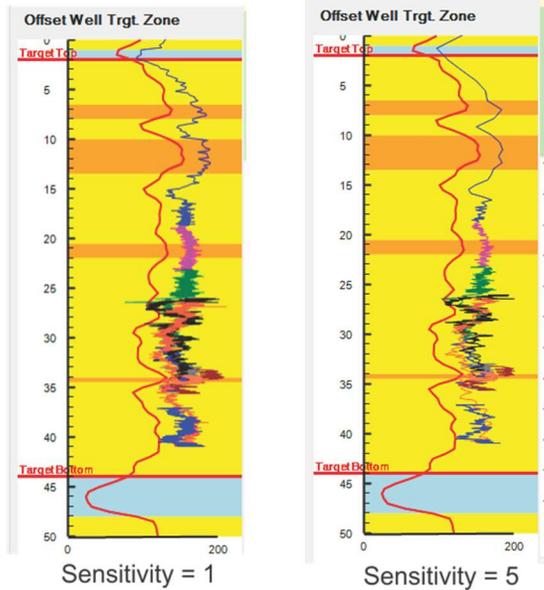


## LWD Tab

Use this tab to control aspects of the LWD curve used in correlation. The first step is to select the curve (usually gamma) that will be used in the correlation. Use the drop down menu to select the appropriate curve that has been imported into the regular logging program.

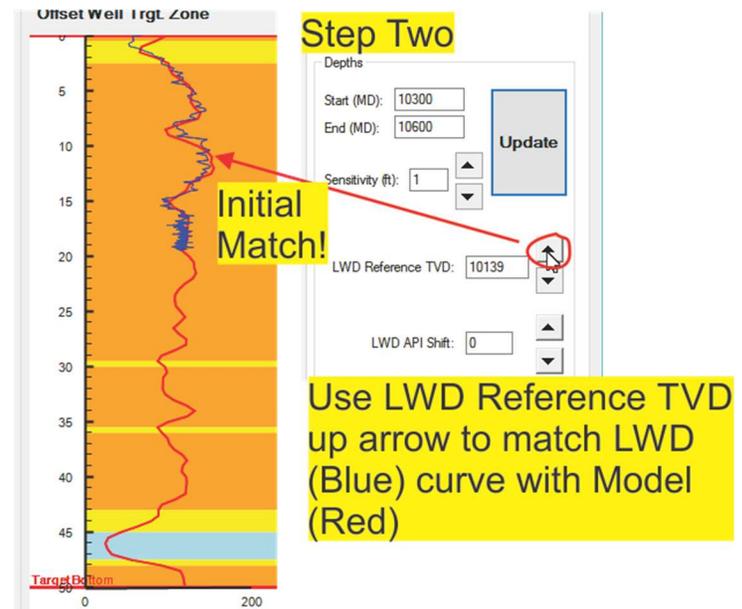
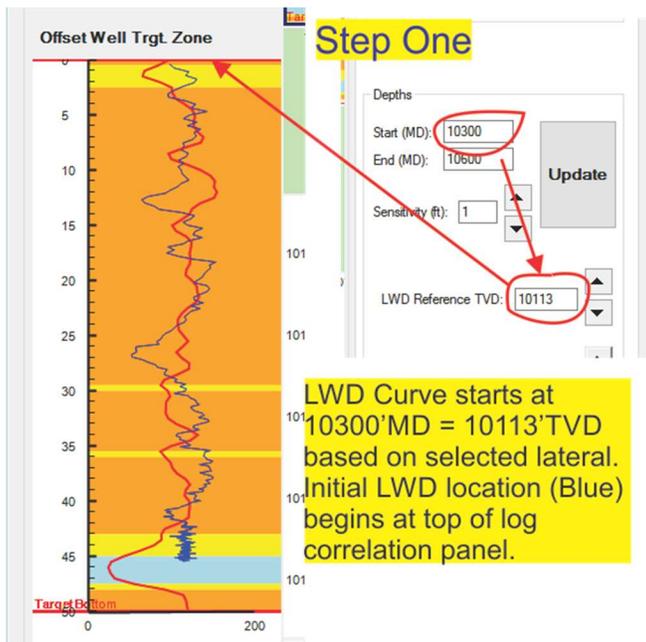
Once selected, the next step is to select a Start and End depth for the LWD data. Even though the regular log may have data starting near the beginning of the well, and far up-hole of where the correlation will take place, most of this data is not needed. Choose a depth near a known correlation point. For the end depth, choose a point past the end planned TD

measured depth. Sometimes you may not want to show all the LWD data, in which case choose a End depth less than the drilled depth, and the program will only show LWD to the chosen End depth.



The Sensitivity value is a way to clear out some of the noise. If set to 1, every LWD data point for every foot drilled will be shown on the log correlation panel LWD curve. If set to 2, then every 2<sup>nd</sup> foot, if set to 3 then every 3<sup>rd</sup> foot etcetera. The below example show the Log-correlation panel with sensitivity set to 1' and to 5'.

The LWD Reference TVD value is used at the beginning of the correlation process to match up the start value of the LWD curve with your model. By default, the LWD curve reference TVD value is the start MD depth's actual TVD value based on the Lateral chosen in the "Lateral Tab". The LWD curve will begin at the top of the Log Correlation panel. Use the "LWD Reference TVD arrow keys to set your initial correlation depth by matching your LWD curve to the model curve. Usually this means clicking the up arrow key until you get a match. See the Below example.



Once the LWD Reference TVD is adjusted for an initial correlation match, it will not be adjusted for the remainder of the geosteering.

The LWD API Shift arrow keys will move the LWD curve left and right as needed to make correlation easier to see.

## Dips Tab

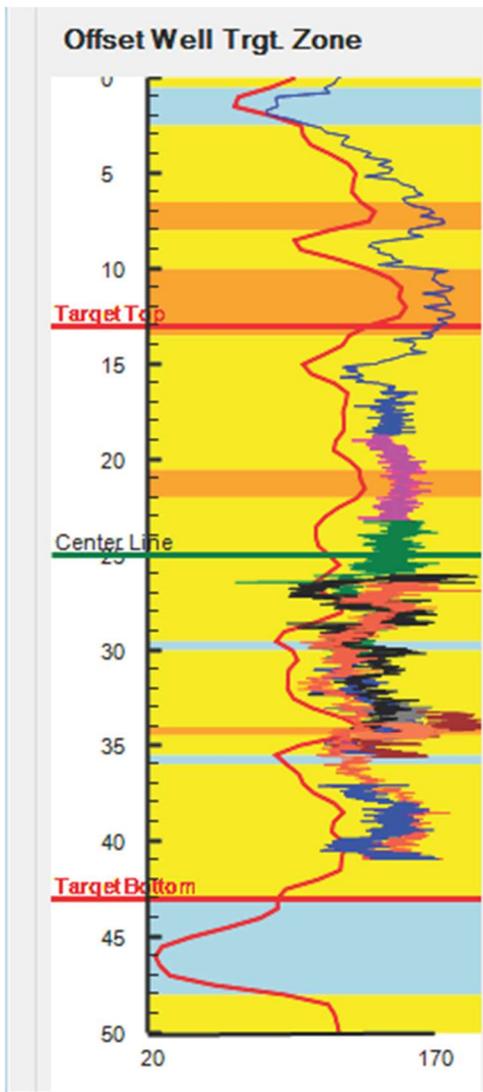
The Dips tab is where you can adjust your dips to make your correlation work. In the below screen shot we have an initial match between our LWD curve (Blue) and our offset gamma, but the dip is not quite correct.



Dips can be added at any interval as the well is drilled ahead.

## Colors Tab

The colors tab can be used to change the color of the LWD gamma curve on both the Log-Correlation panel and the Graph panel to better help with correlation.



TVD Log Lateral LWD Dip(s) Color

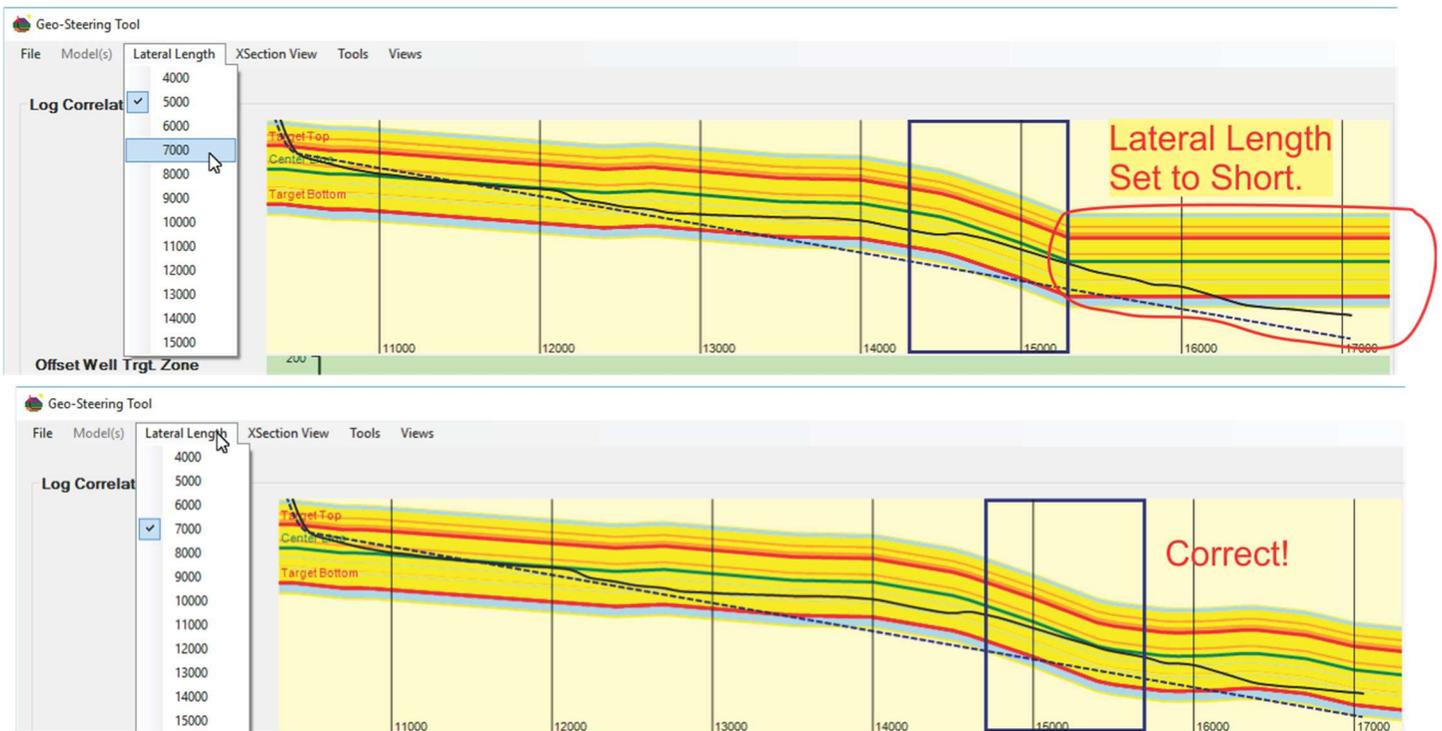
Change Color @ MD

	MD	Color
	0	Blue
	10600	Magenta
▶	10910	Green
	12400	Blue
	12800	Brown
	13500	Gray
	14000	Coral
	14500	Black

Update

### Lateral Length Menu Item

Set the lateral length menu item to the length of the lateral starting at your LWD Tab Start MD depth to the planned TD. For example, if your LWD Tab Start depth is set at 10300' MD and planned TD is 17,200' you would want to set your Lateral length to 7000'. A value that is too short will not compute the whole-well overview panel correctly, and a value that is too long will slow down the program (though it will compute correctly).



## Tools Menu Item

The tools menu item has two items. The Clear Zoom Keys that has been previously discussed and the create Geohorizons tool.

## Create Geohorizons Tool

This tool takes the tops (i.e. Target Top, Target Bottom and any other line) created in the GeoSteering tool and create a geohorizon line at the appropriate location on the log. This line can also be viewed on the TVD vs Vertical Section tool. This way a geohorizon with the correct dips from the Geosteering tool can be transferred to the log. The best way to understand this tool is to experiment. Any line that is transferred to the log from the GeoSteering tool can be deleted using the "Geologic Tops / Horizon Editor" in the "Data Entry/Editors" dropdown menu item (also see Chapter 11 – GeoHorizons and the TVD vs. Vertical Section Well Profile).

<sup>ii</sup> Created a 1.98 MF file from the Example Log.hxl - easily opened by Windows Photo Gallery and good quality.

<sup>iii</sup> Created a 2.38 MB file from the Example Log.hxl - easily opened by Windows Photo Gallery and high quality (better than JPEG).

<sup>iv</sup> Created a 46 MB file from the Example Log.hxl - cannot see any reason to use this format.

<sup>v</sup> Created a 857 KB file from the Example Log.hxl - opens easily in Windows Explorer or Mozilla Firefox, but low quality.

<sup>vi</sup> Created a 1.76 MB file from the Example Log.hxl - opens easily in Windows Explorer or Mozilla Firefox, and high quality.

<sup>vii</sup> I (Peter Falk) have personally worked as the well-site geologist on dozens of horizontal wells using four different directional companies and never seen another method employed.

<sup>viii</sup> It is a good idea to check your numbers with the Directional Driller numbers every few surveys to make positive your numbers match. Nine times out of ten any discrepancies will be a simple typographical data entry error. It is usually easy to find the error by working backwards to where the derived survey values go from not matching to matching.

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<sup>ix</sup> I am thinking of changing that, and allowing images to be added to multiple tracks. Any feedback would be much appreciated. Send your comments to [peter.falk@hmgsoftwarellc.com](mailto:peter.falk@hmgsoftwarellc.com)

<sup>x</sup> I have kept the preloaded images to a minimum focusing on common images that will be useful to all kinds of situations. It has been my experience that most mudloggers restrict themselves to using only a few choice images for a particular well (fossil fragments or minerals, symbols that represents drilling events like a bit trip). Why have a legend full of images that one never uses? Plus, I have received very little feedback (positive or negative) over the years from clients whether they even look at the accessory images added to a log. Again, if you have strong feelings regarding log images, let me know at [peter@horizontalmudlog.com](mailto:peter@horizontalmudlog.com)

<sup>xi</sup> The size of the image is not the size of the image in the "Add Image" dropdown menu, but the size of the image on the log. A quarter inch height and half inch width corresponds to about 48 X 23 pixels. If using "paint" to create images, make sure that the image is under about 48 pixels for the width and 23 pixels for the height in order to insure that the image is displayed in the log legend.

<sup>xiii</sup> Of course, this assumes you have Adobe's PDF Reader or some other PDF viewing software on your computer. To install this free software follow this link: <http://get.adobe.com/reader/>