

WELLPATH – Wellpath Planning and Projection Model

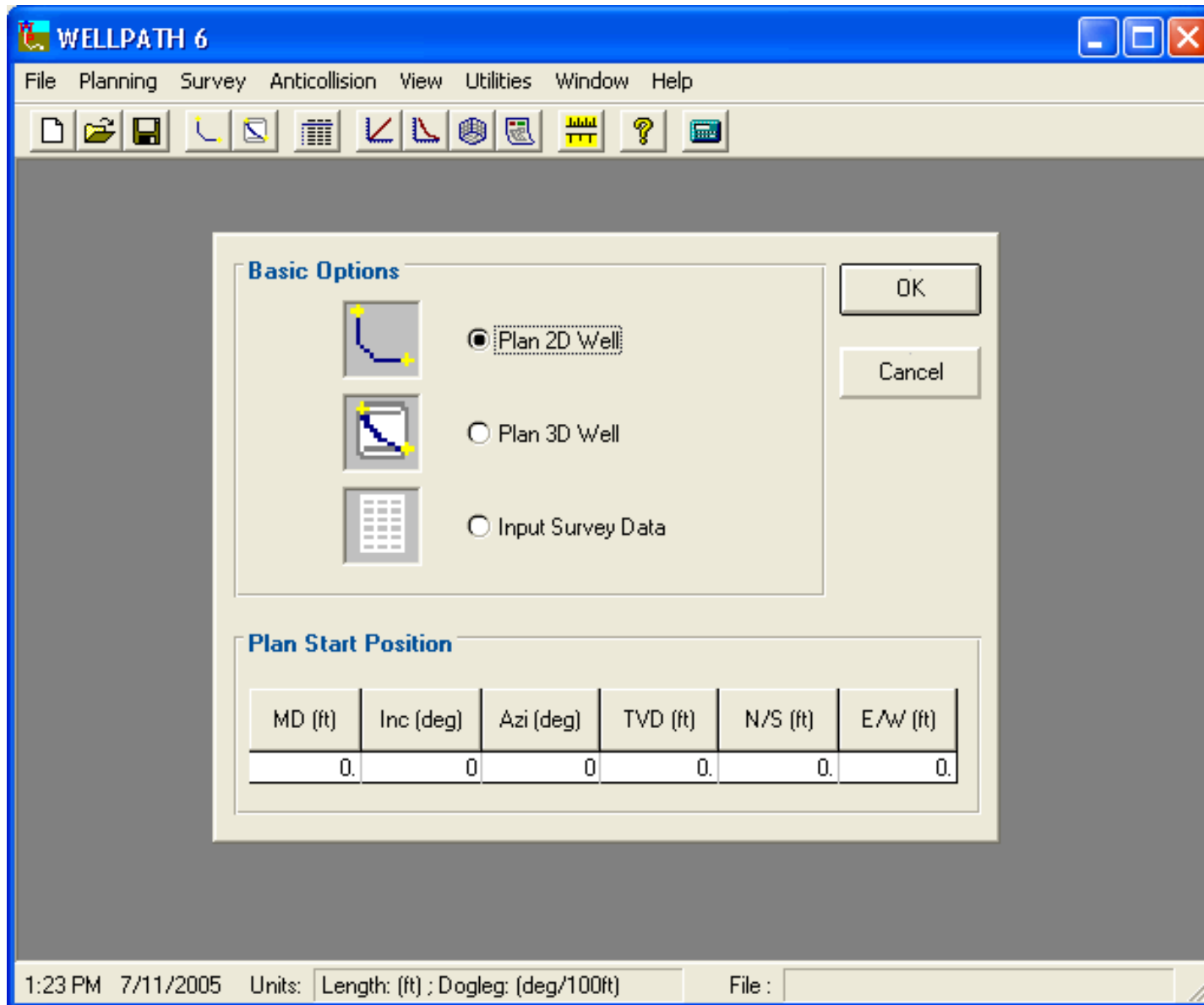
is a powerful and highly versatile engineering tool. The program has proven itself very useful for:

- Designing wellpaths during the well-planning stage
- Projecting wellpaths to determine if targets can be achieved using existing BHAs
- Determining build rates needed to hit targets
- Establishing if additional drilling can be carried out before changing BHAs
- Checking for proximity and collision risks between neighboring wells

WELLPATH allows you to rapidly create 2D or 3D wellpaths, from simple to highly complex.

NOTE: Computer screens within this PDF document may appear slightly distorted. This is due to limitations in the Adobe Acrobat Viewer when displaying graphics. To clearly view details in the graphics, zoom in or print the document.





Among the basic features of **WELLPATH** are “Plan 2D Well” or “Plan 3D Well” to create a new wellpaths section by section based on known geometric constraints. “Input Survey Data” will import an existing survey for comparing/reviewing/editing as required.

WELLPATH 6

File Planning Survey Anticollision View Utilities Window Help

Plan 2D Wellpath

Build & Hold (TVD Target) Single Projection
 Build & Hold (Point Target) **Build & Drop (Point Target)** Build & Build (Point Target)

	MD (ft)	Inc (deg)	Azi (deg)	TVD (ft)	N/S (ft)	E/W (ft)	BR (deg/100ft)
1	0.	0.	0.	0.	0.	0.	0.
2	1800.	0.	0.	1800.	0.	0.	0.
3	2214.	55.	0.	2153.	184.	0.	13.3
4	4014.	55.	0.	3185.	1658.	0.	0.
5	4629.	5.	0.	3702.	1956.	0.	8.1
6	5129.	5.	0.	4200.	2000.	0.	0.

Start

TVD (ft)	N/S (ft)	E/W (ft)
4200.	2000.	0.

Target

NS/EW Horizontal L/Azi (from "Start")

TVD (ft)	N/S (ft)	E/W (ft)
4200	2000	0.

Well Plan

	Unknowns (Select 2)	Geometric Parameters
L1 (ft)	<input type="checkbox"/>	1800.
BR1 (deg/100ft)	<input checked="" type="checkbox"/>	13.3
Inc2 (deg)	<input type="checkbox"/>	55.
L2 (ft)	<input type="checkbox"/>	1800.
BR2 (deg/100ft)	<input checked="" type="checkbox"/>	8.1
Inc3 (deg)	<input type="checkbox"/>	5.
L3 (ft)	<input type="checkbox"/>	500.

10:00 AM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

WELLPATH

To illustrate how simple it is to use **WELLPATH** to develop a complex wellpath, a 2D survey will be created in two stages. For the first stage, we select the “Build & Drop (Point Target)” tab.

WELLPATH 6

File Planning Survey Anticollision View Utilities Window Help

Plan 2D Wellpath

Build & Hold (TVD Target) Single Projection
 Build & Hold (Point Target) **Build & Drop (Point Target)** Build & Build (Point Target)

	MD (ft)	Inc (deg)	Azi (deg)	TVD (ft)	N/S (ft)	E/W (ft)	BR (deg/100ft)
1	0.	0.	0.	0.	0.	0.	0.
2	1800.	0.	0.	1800.	0.	0.	0.
3	2214.	55.	0.	2153.	184.	0.	13.3
4	4014.	55.	0.	3185.	1658.	0.	0.
5	4629.	5.	0.	3702.	1956.	0.	8.1
6	5129.	5.	0.	4200.	2000.	0.	0.

Start

TVD (ft)	N/S (ft)	E/W (ft)
4200.	2000.	0.

Target

NS/EW Horizontal L/Azi (from "Start")

TVD (ft)	N/S (ft)	E/W (ft)
4200	2000	0.

Well Plan

	Unknowns (Select 2)	Geometric Parameters
L1 (ft)	<input type="checkbox"/>	1800.
BR1 (deg/100ft)	<input checked="" type="checkbox"/>	13.3
Inc2 (deg)	<input type="checkbox"/>	55.
L2 (ft)	<input type="checkbox"/>	1800.
BR2 (deg/100ft)	<input checked="" type="checkbox"/>	8.1
Inc3 (deg)	<input type="checkbox"/>	5.
L3 (ft)	<input type="checkbox"/>	500.

10:00 AM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

WELLPATH

The first step is to input the target coordinates of this section of the wellpath.

WELLPATH 6

File Planning Survey Anticollision View Utilities Window Help

Plan 2D Wellpath

Build & Hold (TVD Target) Single Projection
 Build & Hold (Point Target) **Build & Drop (Point Target)** Build & Build (Point Target)

	MD (ft)	Inc (deg)	Azi (deg)	TVD (ft)	N/S (ft)	E/W (ft)	BR (deg/100ft)
1	0.	0.	0.	0.	0.	0.	0.
2	1800.	0.	0.	1800.	0.	0.	0.
3	2214.	55.	0.	2153.	184.	0.	13.3
4	4014.	55.	0.	3185.	1658.	0.	0.
5	4629.	5.	0.	3702.	1956.	0.	8.1
6	5129.	5.	0.	4200.	2000.	0.	0.

Start

TVD (ft)	N/S (ft)	E/W (ft)
4200.	2000.	0.

Target

NS/EW Horizontal L/Azi (from "Start")

TVD (ft)	N/S (ft)	E/W (ft)
4200	2000	0.

Well Plan

	Unknowns (Select 2)	Geometric Parameters
L1 (ft)	<input type="checkbox"/>	1800.
BR1 (deg/100ft)	<input checked="" type="checkbox"/>	13.3
Inc2 (deg)	<input type="checkbox"/>	55.
L2 (ft)	<input type="checkbox"/>	1800.
BR2 (deg/100ft)	<input checked="" type="checkbox"/>	8.1
Inc3 (deg)	<input type="checkbox"/>	5.
L3 (ft)	<input type="checkbox"/>	500.

10:00 AM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

WELLPATH

We then enter the geometric parameters that define the basic wellpath. Two of these are specified as unknown, that is, they will be assigned optimized values based on the other parameters.

WELLPATH 6

File Planning Survey Anticollision View Utilities Window Help

Plan 2D Wellpath

Build & Hold (TVD Target) Single Projection
 Build & Hold (Point Target) **Build & Drop (Point Target)** Build & Build (Point Target)

	MD (ft)	Inc (deg)	Azi (deg)	TVD (ft)	N/S (ft)	E/W (ft)	BR (deg/100ft)
1	0.	0.	0.	0.	0.	0.	0.
2	1800.	0.	0.	1800.	0.	0.	0.
3	2214.	55.	0.	2153.	184.	0.	13.3
4	4014.	55.	0.	3185.	1658.	0.	0.
5	4629.	5.	0.	3702.	1956.	0.	8.1
6	5129.	5.	0.	4200.	2000.	0.	0.

Buttons: Show Parameter, Calculate, Cancel, Print, Sensitivity, Wizard, Show Details, Compare

Start

TVD (ft)	N/S (ft)	E/W (ft)
4200.	2000.	0.

Target

NS/EW Horizontal L/Azi (from "Start")

TVD (ft)	N/S (ft)	E/W (ft)
4200	2000	0.

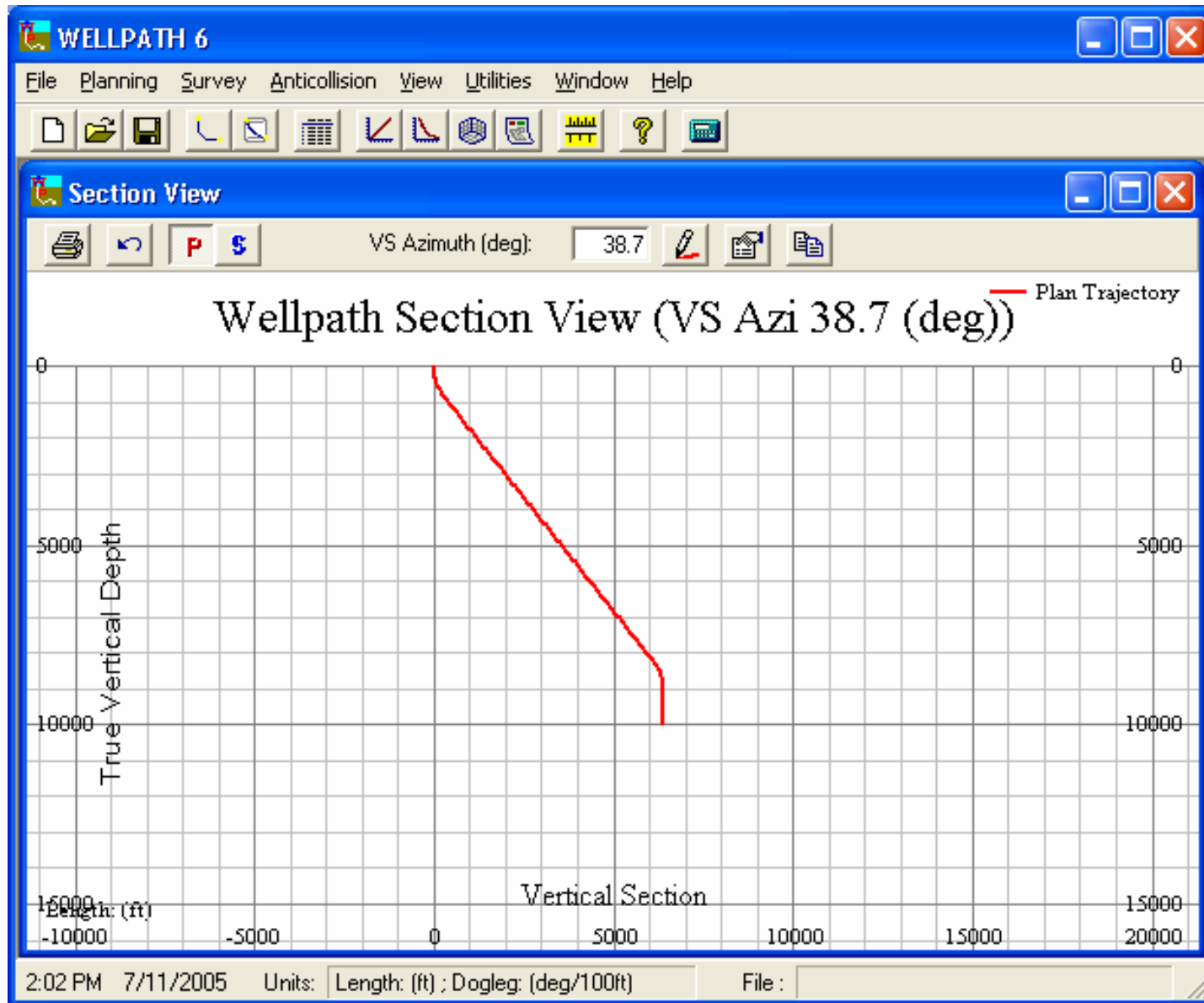
Well Plan

	Unknowns (Select 2)	Geometric Parameters
L1 (ft)	<input type="checkbox"/>	1800.
BR1 (deg/100ft)	<input checked="" type="checkbox"/>	13.3
Inc2 (deg)	<input type="checkbox"/>	55.
L2 (ft)	<input type="checkbox"/>	1800.
BR2 (deg/100ft)	<input checked="" type="checkbox"/>	8.1
Inc3 (deg)	<input type="checkbox"/>	5.
L3 (ft)	<input type="checkbox"/>	500.

10:00 AM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

WELLPATH

Click [Calculate] to create this section of the wellpath. Results are displayed immediately in the table.



WELLPATH

Here is a section view (side view) of the wellpath we just created.

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File Planning Survey Anticollision View Utilities Window Help

Plan 2D Wellpath

Build & Hold (TVD Target) Single Projection
 Build & Hold (Point Target) Build & Drop (Point Target) **Build & Build (Point Target)**

	MD (ft)	Inc (deg)	Azi (deg)	TVD (ft)	N/S (ft)	E/W (ft)	BR (deg/100ft)
1	0.	0.	38.7	0.	0.	0.	0.
2	100.	0.	38.7	100.	0.	0.	0.
3	866.	38.3	38.7	810.	193.	154.	5.
4	10398.	38.3	38.7	8290.	4807.	3846.	0.
5	11165.	0.	38.7	9000.	5000.	4000.	5.
6	12165.	0.	38.7	10000.	5000.	4000.	0.

Start

TVD (ft)	N/S (ft)	E/W (ft)
10000.	5000.	4000.

Target

NS/EW Horizontal L/Azi (from "Start")

TVD (ft)	N/S (ft)	E/W (ft)
15000	10000	7000

Well Plan

	Unknowns (Select 2)	Geometric Parameters
L1 (ft)	<input type="checkbox"/>	0
BR1 (deg/100ft)	<input type="checkbox"/>	0
Inc2 (deg)	<input type="checkbox"/>	0
L2 (ft)	<input type="checkbox"/>	0
BR2 (deg/100ft)	<input type="checkbox"/>	0
Inc3 (deg)	<input type="checkbox"/>	0
L3 (ft)	<input type="checkbox"/>	0

2:07 PM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

WELLPATH

To create a complex wellpath, we can add additional sections to the existing wellpath. We move to the “Build & Build (Point Target)” tab (based on the general shape desired for this section). We now enter new target coordinates.

WELLPATH 6

File Planning Survey Anticollision View Utilities Window Help

Plan 2D Wellpath

Build & Hold (TVD Target) Single Projection
 Build & Hold (Point Target) Build & Drop (Point Target) **Build & Build (Point Target)**

	MD (ft)	Inc (deg)	Azi (deg)	TVD (ft)	N/S (ft)	E/W (ft)	BR (deg/100ft)
7	12965.	0.	31.	10800.	5000.	4000.	0.
8	13608.	45.	31.	11379.	5206.	4123.	7.
9	18492.	45.	31.	14832.	8167.	5900.	0.
10	18942.	90.	31.	15000.	8514.	6109.	10.
11	20674.	90.	31.	15000.	10000.	7000.	0.
12							

Start

TVD (ft)	N/S (ft)	E/W (ft)
15000.	10000.	7000.

Target

NS/EW Horizontal L/Azi (from "Start")

TVD (ft)	N/S (ft)	E/W (ft)
15000	10000	7000

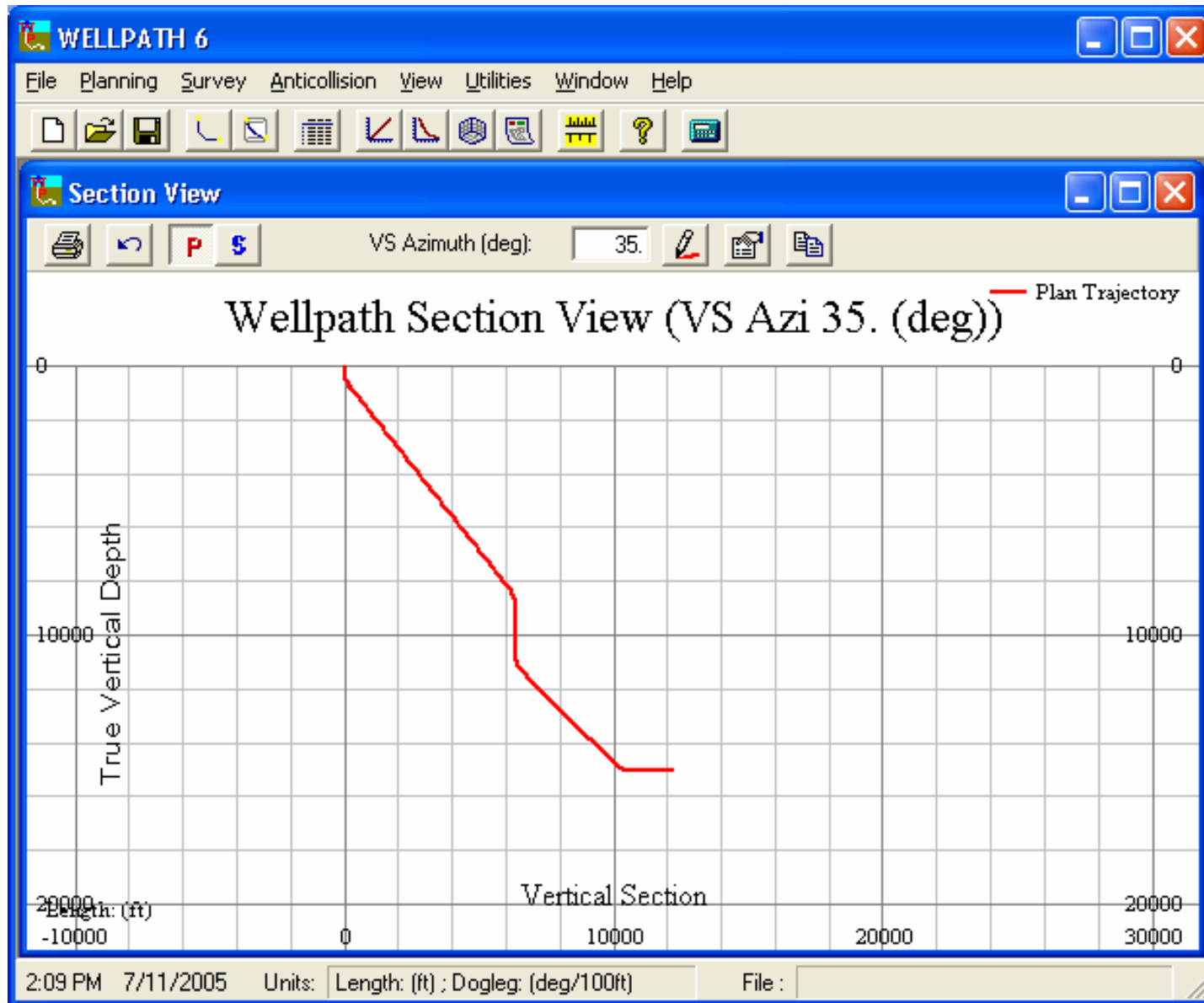
Well Plan

	Unknowns (Select 2)	Geometric Parameters
L1 (ft)	<input type="checkbox"/>	800.
BR1 (deg/100ft)	<input type="checkbox"/>	7.
Inc2 (deg)	<input type="checkbox"/>	45.
L2 (ft)	<input checked="" type="checkbox"/>	4884.
BR2 (deg/100ft)	<input type="checkbox"/>	10.
Inc3 (deg)	<input type="checkbox"/>	90.
L3 (ft)	<input checked="" type="checkbox"/>	1733.

2:08 PM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

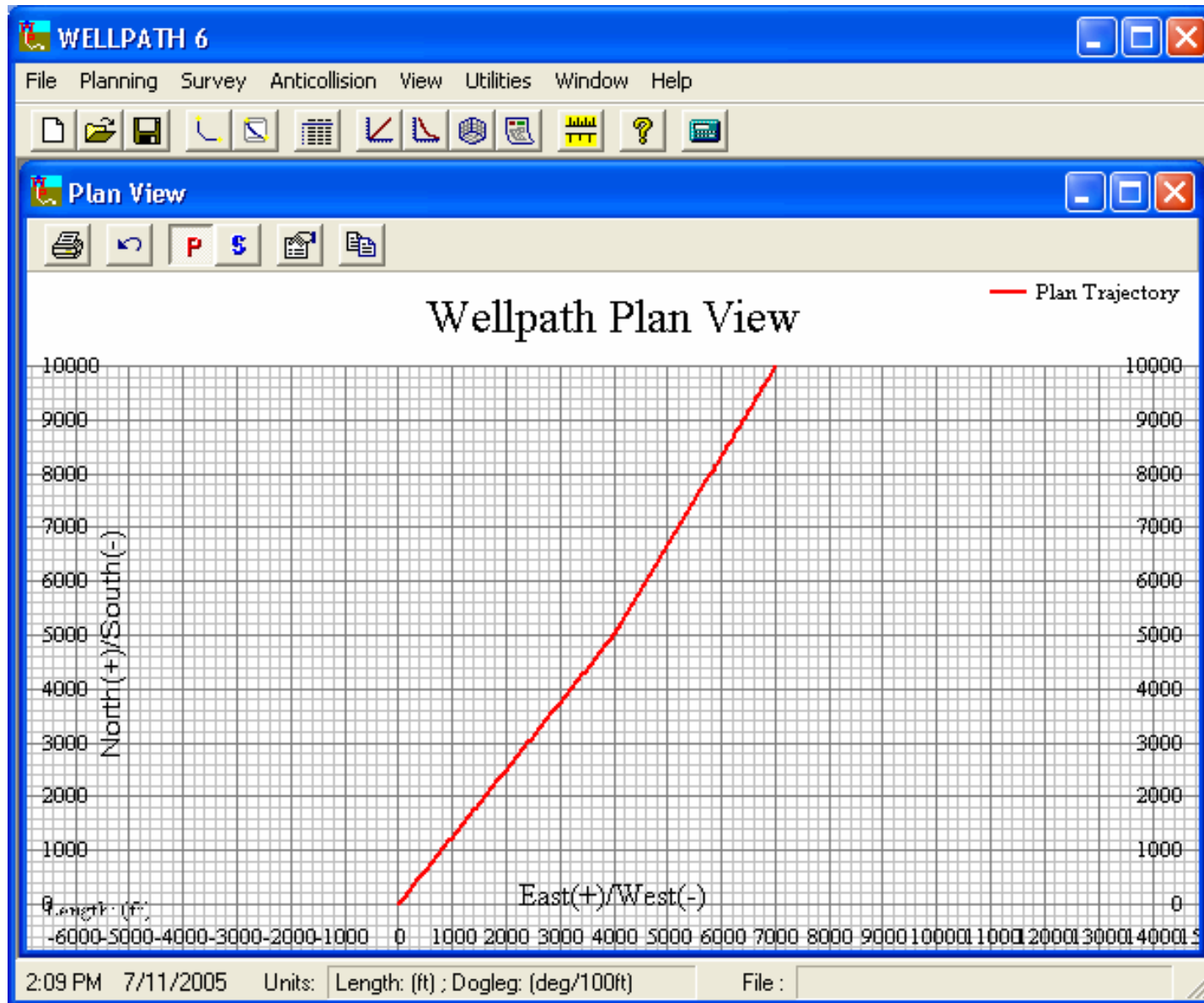
WELLPATH

Enter new geometric parameters (two of which are unknowns), click [Calculate], and the new wellpath section is added onto the previously calculated section. We can continue this step-by-step design method for as many stages as required.



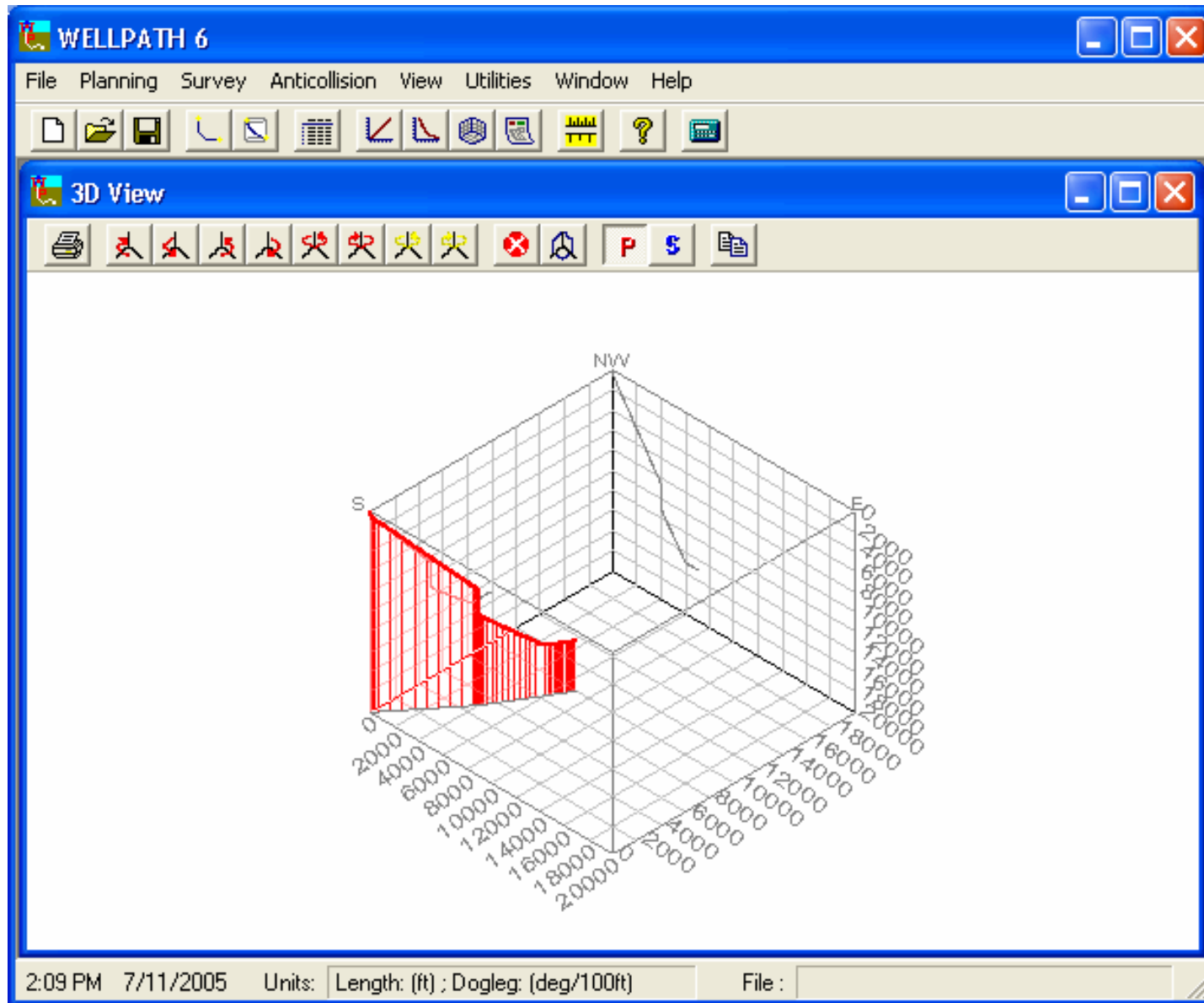
WELLPATH

Here is a section view of the wellpath created in two simple steps.

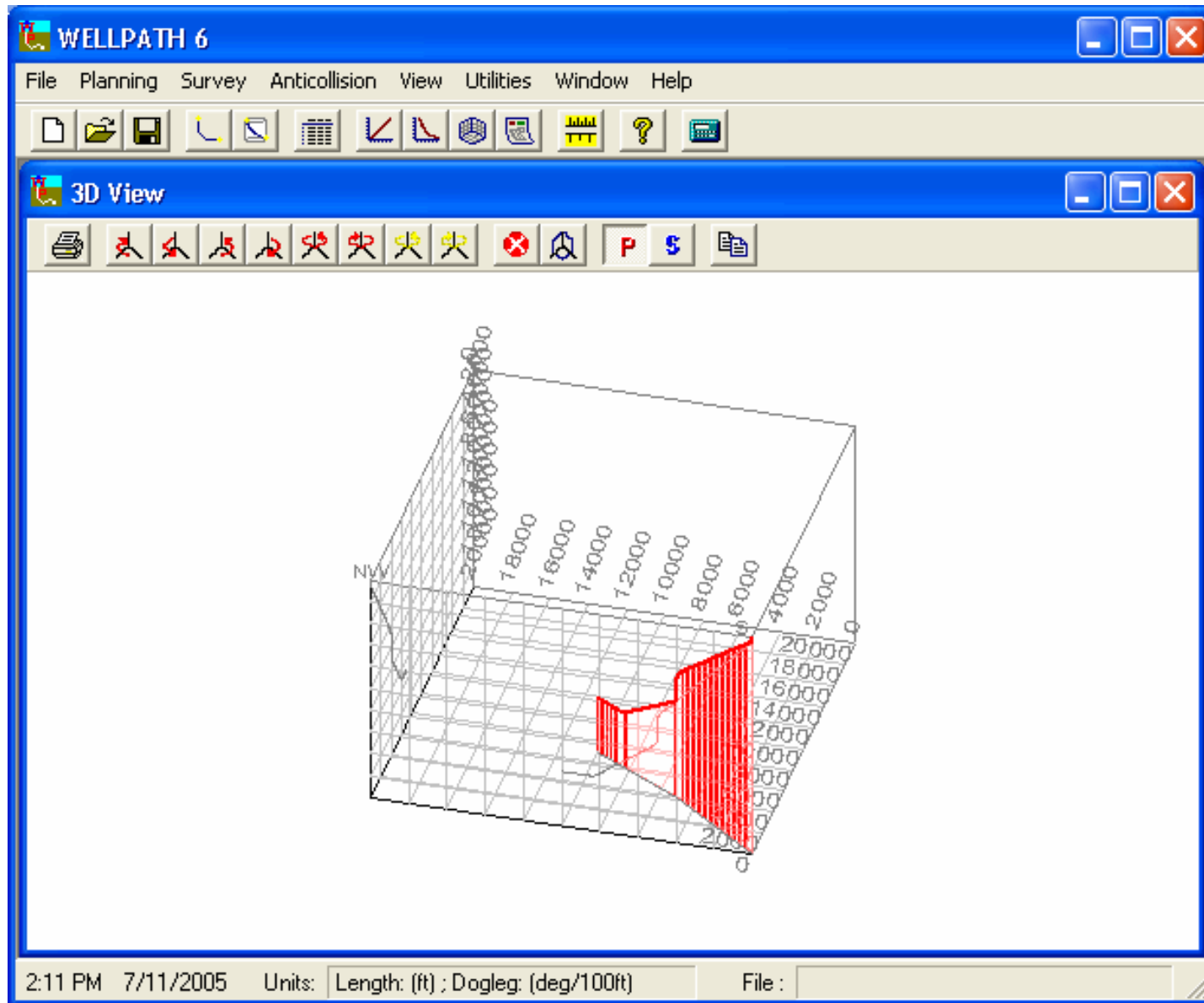


WELLPATH

The Plan View (overhead view) of the same wellpath can be accessed at the click of a button.

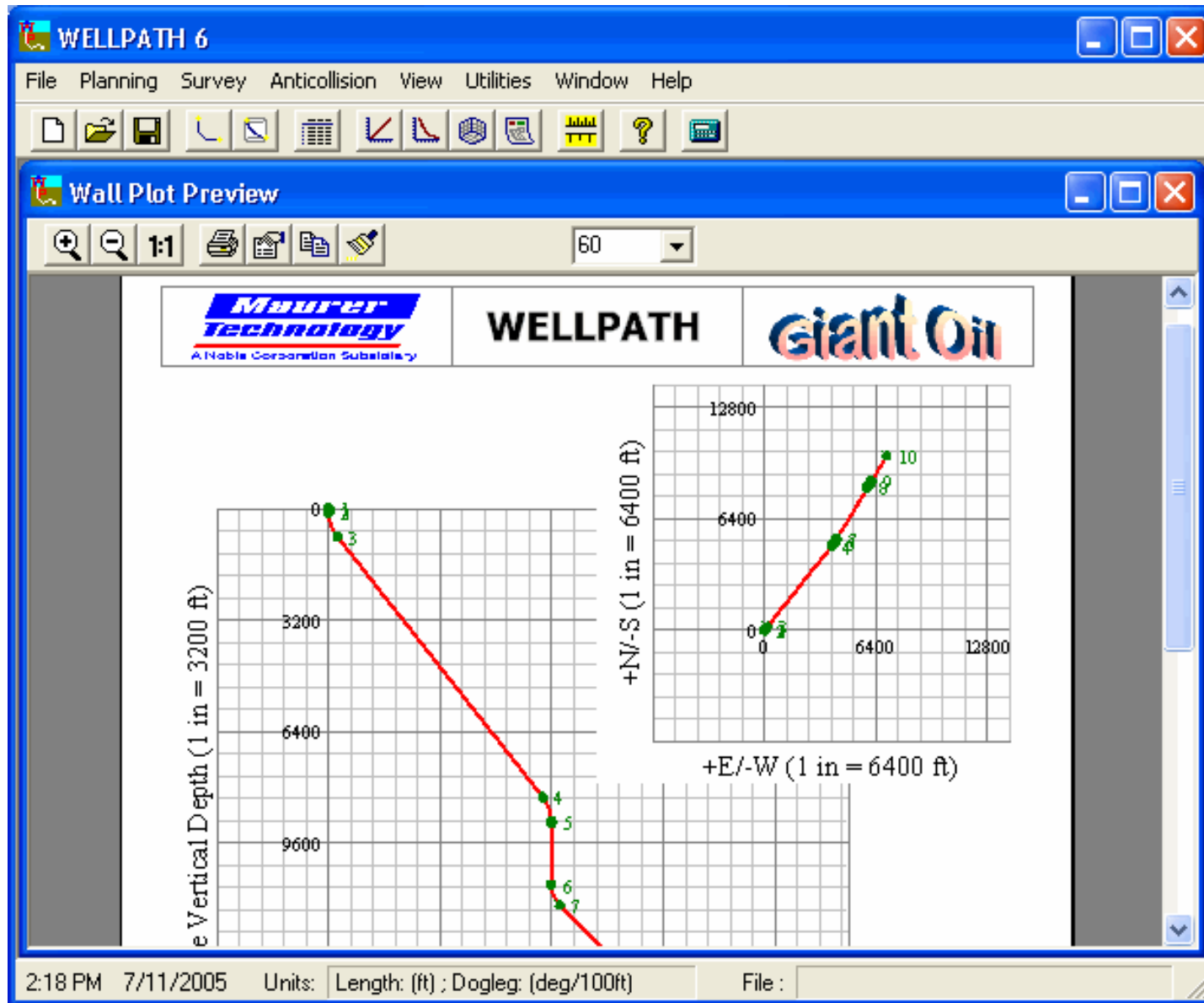


The 3D View window is very useful for visualizing the wellpath in space.



WELLPATH

The cube containing the wellpath can be rotated into any orientation to improve visualization of specific features.



WELLPATH

A wall-plot chart can be printed for posting in the office or field for mapping the well's progress and comparing the actual wellpath to the planned wellpath.

WELLPATH 6

File Planning Survey Anticollision View Utilities Window Help

Survey Data Editor

Survey Table Title: Survey Data Table

	MD (ft)	Inc (deg)	Azi (deg)	TI	TVD (ft)	N/S (ft)	E/W (ft)	V Sec
51	5000.	64.9	24.7	<input type="checkbox"/>	3998.	2316.	1044.	2
52	5100.	66.2	24.7	<input type="checkbox"/>	4040.	2399.	1082.	2
53	5200.	67.5	24.8	<input type="checkbox"/>	4079.	2482.	1121.	2
54	5300.	68.8	24.8	<input type="checkbox"/>	4116.	2567.	1160.	2
55	5400.	70.	24.8	<input type="checkbox"/>	4151.	2652.	1199.	2
56	5500.	71.3	24.8	<input type="checkbox"/>	4185.	2737.	1239.	2
57	5600.	72.6	24.8	<input type="checkbox"/>	4215.	2824.	1278.	2
58	5700.	73.9	24.8	<input checked="" type="checkbox"/>	4244.	2910.	1319.	2
59	5800.	75.2	24.9	<input type="checkbox"/>	4271.	2998.	1359.	2
60	5900.	76.5	24.9	<input type="checkbox"/>	4295.	3086.	1400.	3
61	6000.	77.8	24.9	<input type="checkbox"/>	4318.	3174.	1441.	3
62	6100.	79.1	24.9	<input type="checkbox"/>	4338.	3263.	1482.	3
63	6200.	80.4	24.9	<input type="checkbox"/>	4355.	3352.	1524.	3
64	6300.	81.7	25.	<input type="checkbox"/>	4371.	3442.	1565.	3
65	6400.	83.	25.	<input type="checkbox"/>	4384.	3532.	1607.	3

VS Azimuth (deg) 0.

VS Calculate

Calculate

Print

Insert

Delete

Swap

Sidetrack

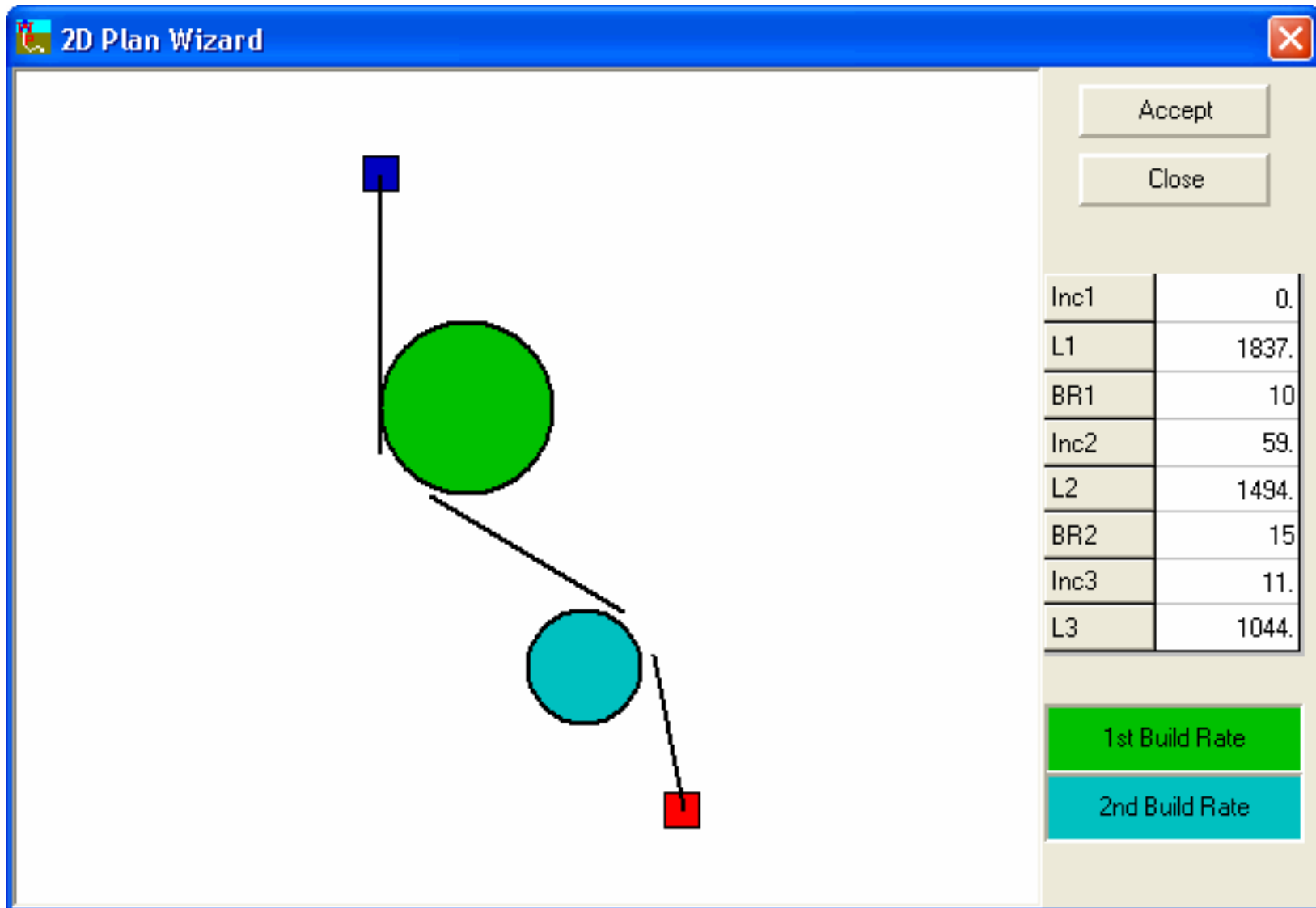
File Format: MTI

Import from MTI Import from Text File Import from Galaxy Export to Plan Export to File

10:51 AM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

WELLPATH

Existing surveys (or those created within **WELLPATH**) can be edited in the Survey Editor. Importing and/or exporting data is easy using any of several formats. The tie-in (TI) feature allows you to specify exact coordinates at any survey station.



WELLPATH

The **Plan Wizard** is a highly useful graphics tool for finding starting values for geometric parameters when they are not well defined. Individual elements of the well can be dragged, stretched, shrunk or rotated on the screen until a feasible shape emerges. These values can then be exported to the plan window as starting points for the wellpath calculation.

Slide

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Estimation Utilities

TFD, TVD (Inc, Azi, DL known)	Inclination in Inclined Pay Zone	Azimuth in Block Coordinate System
Inc vs TR & TFD - (DL, BR known)	TFD vs BR & TR (DL, Inc known)	TFD, DL (Inc, Azi, TVD known)
BAKER INTEQ BHA Build Rate	2D Build Rate (TVD, Inc known)	2D Turn Rate with Same Inc

Top BHA Segment Length L1:
 Bottom BHA Segment Length L2:
 Tilt Angle of Bit Section:
 Bit Geometric Factor (BGF):

BAKER INTEQ BHA Total Build Rate (DL):

If BGF=1, the wellbore will follow the curvature of the BHA.
 SPE/IADC 13474: Performance Drilling Optimization

Calculate Dogleg Severity

L1
 Top Stabilizer
 Bottom Stabilizer
 Tilt Angle
 Bit
 L2
 L3

WELLPATH

A variety of powerful utilities are provided that address a range of problems encountered in direction planning and drilling.

WELLPATH 6

File Planning Survey Anticollision View Utilities Window Help

Plan 3D Wellpath

Curve, Hold & Curve Landing

Single Projection Curve Only **Curve & Hold**

	MD (ft)	Inc (deg)	Azi (deg)	N/S (ft)	E/W (ft)	DL (deg/100ft)	TFO (deg)	BR (deg/100ft)
1	0.	0.00	0.00	0.	0.	12.50	9.98	12.3'
2	100.	12.31	44.49	8.	7.	12.50	9.98	12.3'
3	200.	24.62	51.60	28.	31.	12.50	9.98	12.3'
4	292.	35.95	55.60	56.	69.	12.50	9.98	12.3'
5	6751.	35.95	55.60	2197.	3196.	0.00	0.00	0.00

Start Point

TVD (ft)	N/S (ft)	E/W (ft)
5500.	2197.	3196.

Target

NS/EW Polar Coordinates

TVD (ft)	N/S (ft)	E/W (ft)
5500.	2200.	3200.

Well Plan Criteria:

Variable TFO Constant TFO

Curve Section Specification

DL (deg/100ft): 12.50

Ending TVD (ft): 0.00

Ending Inc (deg): 0.00

Starting Azi (deg): 55.60

Calculate
Cancel
Print
Stop

2:49 PM 7/11/2005 Units: Length: (ft) ; Dogleg: (deg/100ft) File :

WELLPATH

True 3D projections based on **constant tool-face orientation (TFO)** can also be generated. **WELLPATH** is the first program with this capability. Drilling operations in the field are greatly simplified if the TFO can remain constant as the curve progresses.

Anticollision Analysis for Multiple Wells

File View Anticollision Tools

Current Well: Hazelnut H-34 (row: 5)

	Well Name	Well Head TVD (ft)	Well Head NS (ft)	Well Head EW (ft)	Hole Size (in)	Survey Tool	Reference Well (select one)	Compared Wells	Well TMD (ft)
1	Plan Data	0.	0.	0.	10.	MWD	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1515.
2	Survey Data	0.	-100.	-300.	12.	GMS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1000.
3	Example Z	0.	100.	200.	8.	MWD	<input type="checkbox"/>	<input checked="" type="checkbox"/>	4463.
4	Example M	50.	200.	300.	10.	SDD	<input checked="" type="checkbox"/>	<input type="checkbox"/>	15000.
5	Hazelnut H-34	0.	50.	50.	9.	GMS	<input type="checkbox"/>	<input checked="" type="checkbox"/>	8000.
6	Example G	50.	100.	100.	0.	MWD	<input type="checkbox"/>	<input checked="" type="checkbox"/>	9300.
7							<input type="checkbox"/>	<input type="checkbox"/>	
8							<input type="checkbox"/>	<input type="checkbox"/>	
9							<input type="checkbox"/>	<input type="checkbox"/>	
10							<input type="checkbox"/>	<input type="checkbox"/>	

Check Interval: (ft)

Remove Well Import from MTI File Import from Iext File Import from Galaxy

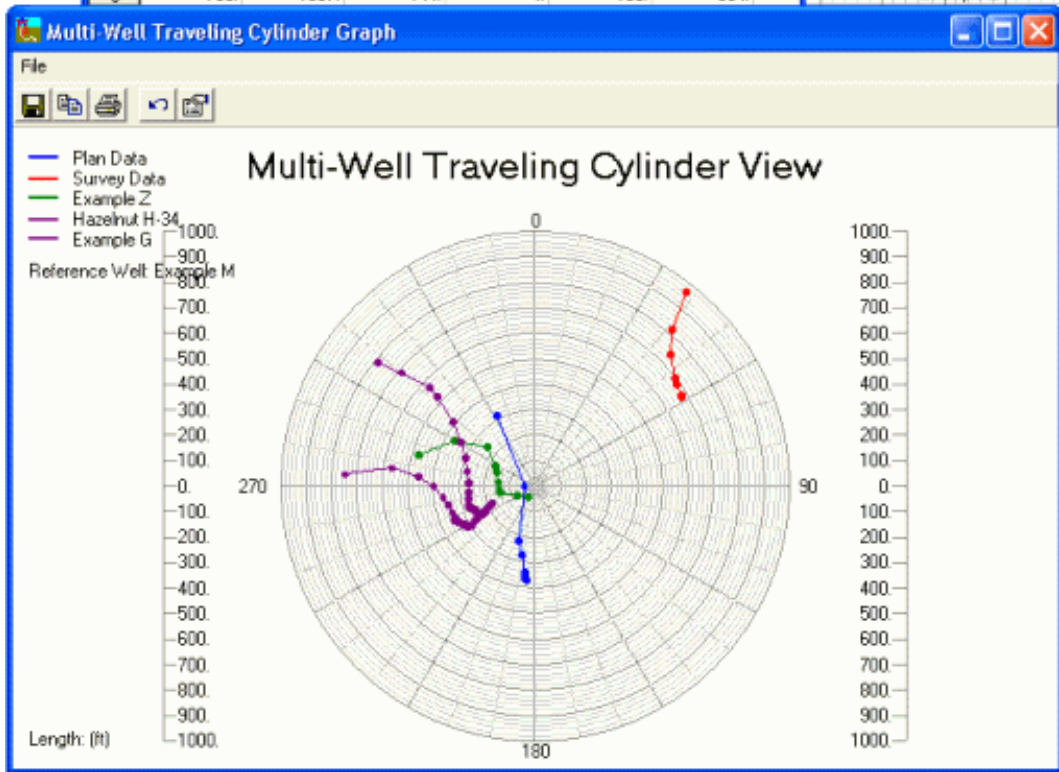
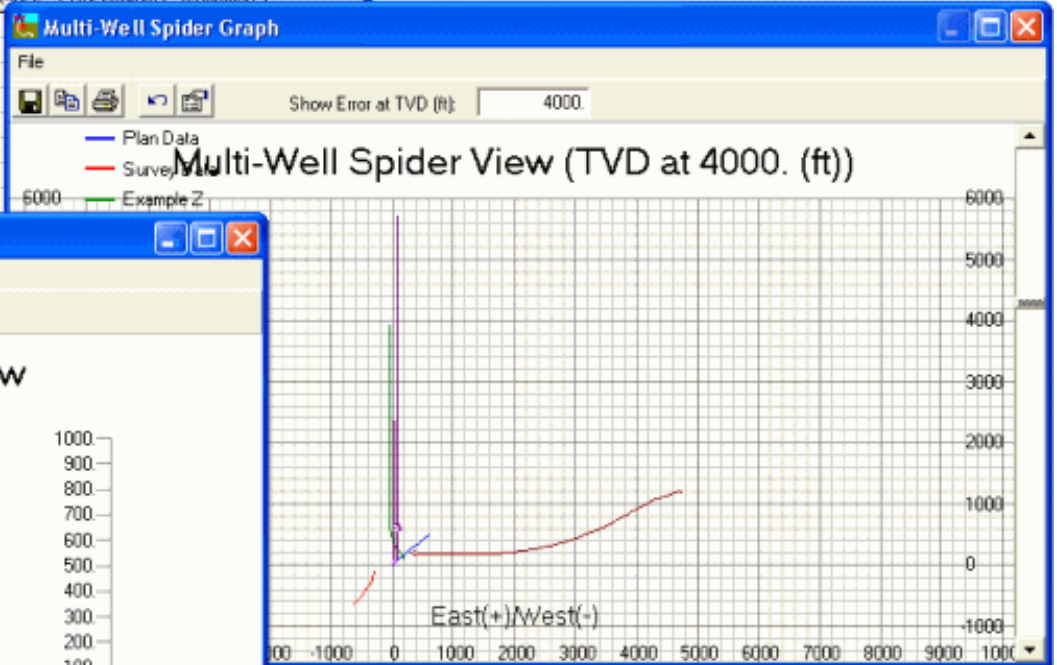
C:\MEI\WELPATH6\AlphaPlatform.ATC 7/11/2005 9:57 AM

WELLPATH

A powerful arsenal of tools is provided for analyzing **wellbore collision**. For offshore environments, collision can be checked for up to 10 wells at a time. Measurement uncertainty can be assigned to each well by selecting a specific survey tool (for which depth-related error and uncertainty can be defined).

Collision Check Results - Summary

#\ (ft)	Ref MD	Comp-1 MD	Comp-1 Min Distance	Comp-1 Uncertainty	Comp-1 Separation	Comp-2 MD	Comp-2 Min Distance	Comp-2 Uncertainty	Comp-2 Separation	Comp-3 MD
1	0	50	361	1	360	32				
2	100	150	361	1	360	90				
3	200	250	362	2	360	147				
4	300	350	364	2	362	196				
5	400	450	367	3	364	242				
6	500	998	332	3	329	282				
7	600	1029	237	4	233	321				
8	700	1057	144	4	139	354				



WELLPATH

Anticollision results are displayed in several formats including tables, a Traveling Cylinder plot (which displays polar positions of offset wells from the center of the reference wellpath), and a Spider View (a plan view of all well trajectories with corresponding uncertainties at each depth).

Geodetic Calculator

Ellipsoid Options:

Enter Ellipsoid Manually

Load an Existing Ellipsoid Dictionary

Dictionary in use: C:\MEI\WELPATH6\dicts2.mdb

Ellipsoid Name: HAYFORD-1909/INTERN.

Square Eccentricity: 0.00672267

Semi-Major Axis: 20926470.

Reference Point Absolute Geographical Coordinates:

deg.min:sec decimal

Latitude: 25 45 12 N S 25.75333333

Longitude: 56 45 18 E W 56.75500000

Limitations:

Maximum Latitude: 60.

Maximum Distance: 98425

Displaced Location:

Absolute Geographical Coordinates:

deg.min:sec decimal

Latitude: 25 45 23.8854 N S 25.75663482

Longitude: 56 45 19.1484 E W 56.75531900

Cartesian Coordinates:

North Displacement: 1200

East Displacement: 105

Polar Coordinates:

Displacement: 1205.

Azimuth: 5.

Length Unit: (ft)

Close

WELLPATH

A Geodetic Calculator is included for converting geographic latitude and longitude of existing wells to a specified Cartesian grid system; and then converting new well locations to geographic latitude and longitude.

Help for WELLPATH

File Edit Bookmark Options Help

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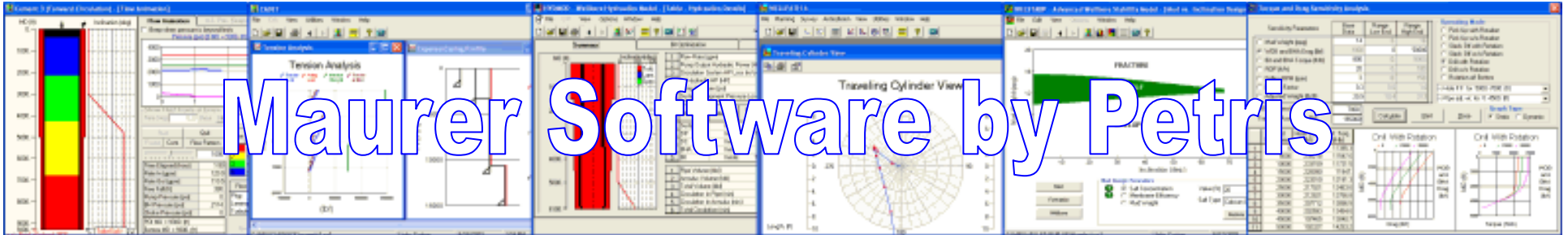
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2D Plan Target Specification

Select between two options for specifying the end point of the section currently being designed. The first option is to use compass direction, where the surface location is the coordinate origin (N/S = 0, E/W = 0). Another option is to specify horizontal displacement ("horizontal projection" in the figure) and azimuth. After selecting the preferred option, enter the required data in the text boxes.

WELLPATH

A complete **On-line Help System** is available. Click [F1] or the help icon for context-sensitive assistance with program operation.



Thanks for your interest in **WELLPATH**

*For more information on Maurer Software by Petris,
email:*

sales@petris.com

or visit us on the web at
www.petris.com

PETRIS