AADE-12-FTCE-28

Streamline Mud Reporting and Management

Yuan Yao, Pegasus Vertex, Inc; Chuck Light, Anchor Drilling Fluids USA, Inc

Abstract

Historically, mud engineers used paper form to record mud properties every morning. With the introduction of MS Office Excel, people began to take advantage of electronic filing. This greatly enhances the reporting quality and filing. However, the part critically missing with this approach is probably the organization of numeric daily reports and generation of end-of-well recap, not to mention the well comparison, which requires obtaining histories of drilling activities over periods of time of multiple wells in various geographical areas.

The modern approach of mud reporting is to use software with the database backbone to perform solids analysis, hydraulics calculation, keep track of all inventory and cost and quickly generate cost overall view. By looking at the end-of-well recap, mud engineers and company men can easily identify the most costly drilling interval and make necessary modification on mud program for the next well. As this new technology evolves, it has great benefits of presenting much more meaningful details to both mud and oil companies..

Using case studies, this paper addresses how computerized mud reporting can streamline the mud operation.

Introduction

Mud engineers have been using Excel spreadsheets or similar software application to generate daily mud reports. Because of the inherent limitation of Excel sheets or the shortcomings of the software, they are usually not adequate enough to meet requirements from mud companies or operator companies.

Some major problems of current reporting software are list below:

1, Repeated data input every day
2, Time-consuming and error-prone hand calculation
3, Report transmit
4, Report management
5, End-of-well recap
6, Lack of necessary features or software

As part of the ongoing efforts to overcome these challenges we are facing, a new mud reporting software has been developed by Pegasus Vertex, Inc and Anchor Drilling Fluids. This software has been used in the fields around the world by more than 20 companies in the past 2 years.

Basic function

The software is designed for both mud engineers at the rig sites and the company men in office. The most basic purpose of this software is for a mud engineer to record mud information and generate daily mud reports. It can also be used by company men for reviewing and managing data, making an end-of-well recap and comparing data between multiple wells.

The software contains many engineering calculations, such like solids analysis, bit optimization, wellbore hydraulics, additive concentration, mud volume, etc. It replaces hand calculations, and provides more accurate results. With the input mud properties and hydraulics results, mud engineers will be able to see if the drilling hydraulics is effectively. The rheology results and additive concentration give mud engineers a clear idea if the mud is in good condition. The mud volume calculation shows the exact volume for each section of the hole, and the pits volume and storage volume as well, so mud engineer can know how much mud is required or lost. Solids analysis can work with water-based, oil-based and synthetic based mud. In different type of mud, the software requires different parameters and calculates for different results.

The software also helps mud engineer select proper mud. User can input several mud samples with different properties, and let the software predict the cuttings clearance and hydraulics. By comparing the results, engineer can select the best prescription of mud.

Such software normally has two types of data transmission methods. One is “terminals to server”, shown as Fig 1, the other is “terminal to terminal”, or “point to point” (P2P), shown as Fig 2. The “terminals to server” model requires an intranet and a server station to support the data transmission. Daily mud reports are created by terminal computers at rig sites, and then transferred to a central server in office. The central server stores data of all wells. A mud engineer with

administrative privilege can log in the server to review the data and maintain the server. The P2P model, used in this software, is a simpler and more flexible model. It does not require a server station or an intranet. All the terminals are in equal level, and one terminal can send data to any other terminals. With the P2P model, a mud engineer can send a well file to anyone via Email, and the person who receives this file can open it on his computer, so he can review the data or print out a same report. If the Internet signal is not available at the rig sites, the mud engineer can save the data in his computer and send it to office later whenever the Internet is ready.

Usability

Usability of any software is an important factor of the quality of the software. A user-friendly interface not only makes the program structure easy to understand, but also allow the users to input data efficiently and accurately, creating pleasant experience. A main interface is shown as Fig. 3. The interface of the software is so straight-forward that an entry-level engineer can easily understand everything in the interface without receiving any training. One can see that, the items in the interface are grouped by their categories.

Flexible designs

Comparing with Excel spreadsheets or some other reporting tools, this software provides user many unique and flexible designs. The well carry-over function is one of them. It can copy the data of a completed well to a newly started well, so the user doesn't have to input duplicated information again. Meanwhile, the ending inventory of the previous well will become the initial inventory of the new well. This function is very effective when all the left-over of a well is delivered directly to a new well.

Once a new report is created, a button can allow user to copy the data from previous day to today's report, then user can just update some changed data and left the unchanged data as it was. In this way, user doesn't need to rewrite same information over and over again.

Keeping track of mud data is vital to mud companies and operators. To make this task easy, the software is equipped with a database for daily mud properties, product inventory, cost and operation parameters. This database can include daily information for multiple wells. Management can import various database created by different engineers and to make an all inclusive database for all the wells drilled for certain period of time. Well comparison can then be done using the integrated database. Another benefit of the database is that engineer can use an existing well and modify it for the new well so that all the product information does not have to be re-typed.

The mud reporting software has an intelligent warning system which can reduce the chance for error. Algorithms within the program aid the user to input correct data by providing calculations and messages. It can give user a warning message when some input error is detected or when some required filed is missing.

Furthermore, the software gives the flexibility to change data in past reports, although the past data is rarely changed after the daily mud report has been sent out. However, if the prices of some products change or a mud engineer made a server mistake in the past reports, then the software allows users to come back to a historical report and change the data. If the changed data associates with some other data, then automatic changes will apply to those associated data as well. For example, during drilling a well, if the engineer finds an incorrect price, he is able to go back to the beginning of this well and make the correction. Then the software will apply the new price to all existing reports and recalculate the cost of this product for each day and the total cost as well. Price change can be applied any specific period of time.

Reporting

The daily report generated by the program not only meets the standards of API mud report format, but also provides additional information. A sample of daily mud report is shown as Fig.4. Depending on the requirements, users have the option to hide the product price and cost, only show the daily total cost instead. This will safeguard the confidential information in case users choose to do so.

Data management

An end-of-well report, or called recap report which contains all data information of the drilling progress, is always required by operating company when a well is finished. Manual coping data from all mud reports and then pasting to a well recap report is a fussy and time-consuming job. Normally to make a recap report for a 60-days well may take about 5 hours or even more. But with the help of the software, generating such an end-of-well report becomes effortless, as simple as a click of a button. A recap report containing data charts and graphs will be generated in a few seconds. In addition, if the planned data is provided to the software, then recap can display both planned and actual data. A graph of MD vs. drilling days is shown in Fig. 5. In this graph, the green line indicates the planned data, while the blue line the actual data. With the plot of both lines, user can compare them and find out which section of the well is drilled faster or slower than expected. Then he could find out why the drilling progress is delayed and try to avoid similar issue for the next well. A pie chart is created by the software, shown in Fig. 6. This chart shows the cost distribution of each product used in this well and the total cost as well.

The software is able to set up drilling intervals. User can define interval names for a well, such like conductor, surface casing, intermediate casing and etc, then the software can summarize the data for one selected interval and generate a interval summary report.

Well comparison is a unique function of this software. It allows user to select up to 10 wells and compare their data, including drilling speed, daily cost, mud properties and etc. The software can also print out a comparison report. With the comparison results, user can summarize drilling experience and apply them to next well.

Fig. 7 shows the comparison of total cost of 4 wells, while Fig. 8 shows the comparison of cumulative cost. The bar charts can also shows comparison of cost per ft and cost per day. With those bar charts, user can investigate drilling cost efficiency and optimize drilling operations for the most economical operation.

Conclusion

Drilling mud business may have been associated with advanced chemistry, rheology, etc, but advanced computer technology, especially software, streamlines the mud engineers' daily job as shown in the following list:

1, Standardizes the input, calculation and reporting.
2, Reduces chances of errors
3, Clarifies the communication between mud companies and operators.
4, Reveals and identifies problems
5. Provides better guidance for future operations
6. Saves time and enhances job performances

Acknowledgments

We thank Anchor Drilling Fluids for technical guidance during this development. We also want to extend our appreciation to our intelligent developers, E. Wang and H. Hu who make this software a reality.

References

1. B.K.Quay: "Daily Drilling Reporting System: Design/Usage." Paper SPE 15283 presented at the Symposium on Petroleum Industry Application of Microcomputers of the SPE held in SilverCreek, CO, June 18-20, 1986.

2. E.K. Morton: "Computer Database Program Provides Drilling MUD System Analysis at Rigsite." Paper SPE 16499 presented at the Petroleum Industry Applications of Microcomputers held in Del Lago on Lake Conroe, Montgomery, Texas, June 23-25, 1987.

3. S. Corless: "Implementation of a Drilling Database System." Paper SPE 23016 presented at the SPE Asia_Pacific Conference held in Perth, Western Australia, November 4-7, 1991.

4. R.V. Westermark, K.J. Hoff and C.M. Boyer: "Computerized Drilling Reports Strengthen Management's Decision Process." Paper SPE 27926 presented at the SPE Mid-Continent Gas Symposium held in Amarillo, Texas, May 22-24, 1994.

Appendix

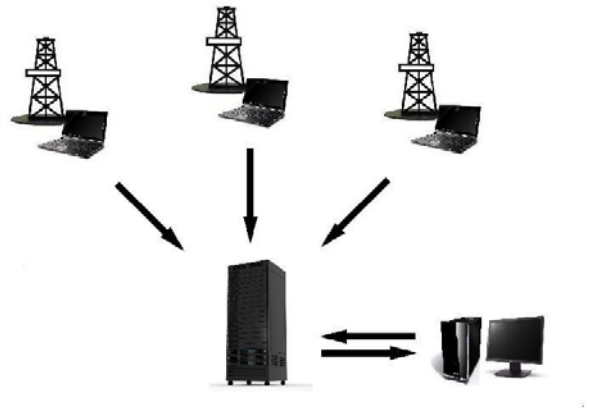


Fig. 1 – Terminals to server model

Fig. 2 – Terminal to terminal model

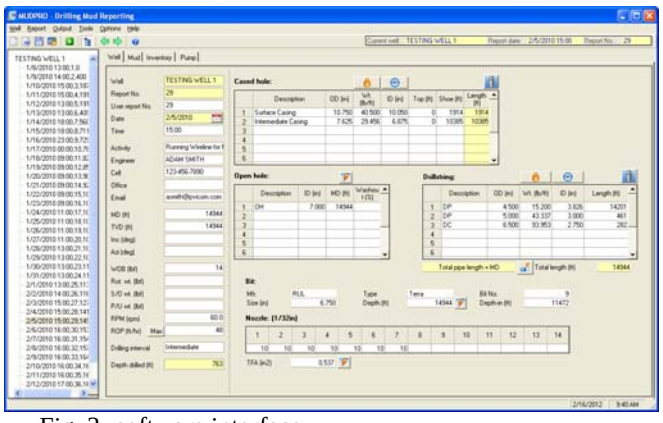
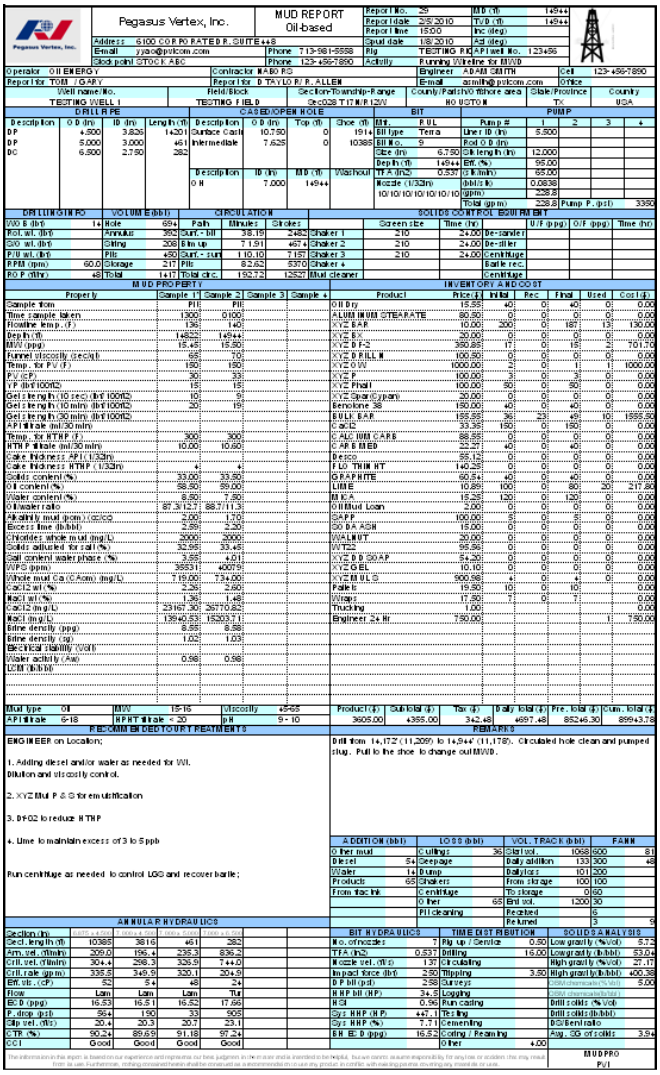


Fig. 3- software interface


Pegasus Vertex, Inc.

MUD REPORT
Oil-based

Report No. 29 | MD (ft) 14944
Report date 2/5/2010 | TVD (ft) 14944
Report time 15:00 | Inc (deg)
Spud date 1/8/2010 | Azi (deg)

Address 5100 CORPORATE DR. SUITE 448
Email yyao@pvtcom.com | Phone 713-981-5558 | Rig TESTING RIG | API well No. 123456
Slickpoint STOCK ABC | Phone 123-456-7890 | Activity Running Wireline for MWD

Operator OIL ENERGY | Contractor NABO RIG | Engineer ADAM SMITH | Cell 123-456-7890
Report for TOM / GARY | Report for D TAYLO R/ R. ALLEN | E-mail asmith@pvtcom.com | Office
Well name/No. TESTING WELL 1 | Field/Block TESTING FIELD | Section/Township/Range Sec028 T17N R12W | County/Parish/Offshore area HOUSTON | State/Province TX | Country USA

DRILL PIPE

Description	OD (in)	ID (in)	Length (ft)
DP	4.500	3.826	14201
DP	5.000	3.000	461
DC	6.500	2.750	282

CASED/OPEN HOLE

Description	OD (in)	Top (ft)	Shoe (ft)
Surface Casi	10.750	0	1914
Intermediate	7.625	0	10385

Description	ID (in)	MD (ft)
O H	7.000	14944

Washout

BIT

Bit	RIL
Bit type	Tetra
Bit No.	9
Size (in)	6.750
Depth (ft)	14944
TFA (in2)	0.537
Nozzle (1/32in)	10/10/10/10/10/10/10/10

PUMP

Pump #	1	2	3	4
Liner ID (in)	5.800			
Rod O.D (in)				
Stk length (in)	12.000			
Eff.(%)	98.00			
(bbl/stk)	0.0838			
(gpm)	228.8			
Total (gpm)	228.8	Pump P. (psi)		3380

DRILLING FLUID | VOLUM E (bbl) | CIRCULATION

MW (lb/g)	14	Hole	694	Path	Minutes	Strokes
Rot. wt. (lb/ft)		Annulus	392	Surf. - bit	38.19	2482
Slid wt. (lb/ft)		Riser	206	Bit to up	7.191	467 4
P/U wt. (lb/ft)		Pits	450	Surf. - surf	110.10	7157
RPM (rpm)	60.0	Storage	217	Pits	82.62	5370
RO P (ft/hr)	48	Total	1417	Total circ.	192.72	12527

SOLIDS CONTROL EQUIPMENT

	Screen size	Time (hr)	U/F (ppg)	O/F (ppg)	Time (hr)
Shaker 1	210	24.00	De-sander		
Shaker 2	210	24.00	De-silter		
Shaker 3	210	24.00	Centrifuge		
Shaker 4			Bottle rec.		
Mud cleaner			Centrifuge		

MUD PROPERTY

Property	Sample 1	Sample 2	Sample 3	Sample 4
Sample from	PIT	PIT		
Time sample taken	1300	0100		
Flowline temp. (F)	136	140		
Depth (ft)	14852	14944		
MW (ppg)	15.45	15.50		
Funnel viscosity (sec/qt)	65	70		
Temp. for PV (F)	150	150		
PV (cP)	30	33		
YP (lb/100ft2)	15	15		
Gel strength (10 sec) (lb/100ft2)	10	9		
Gel strength (10 min) (lb/100ft2)	20	19		
Gel strength (30 min) (lb/100ft2)				
API filtrate (ml/30 min)				
Temp. for HTHP (F)	300	300		
HTHP filtrate (ml/30 min)	10.00	10.60		
Cake thickness API (1/32in)				
Cake thickness HTHP (1/32in)	4	4		
Solids content (%)	33.00	33.50		
Oil content (%)	58.50	59.00		
Water content (%)	7.50	7.50		
Oil/water ratio	87.3/12.7	88.7/11.3		
Alkalinity mud (pom) (cc/cc)	2.00	1.70		
Excess lime (lb/bbl)	2.38	2.35		
Chlorides whole mud (mg/L)	20000	20000		
Solids adjusted for salt (%)	32.98	33.48		
Salt content water phase (%)	3.66	4.01		
WPS (ppm)	29.61	40016		
Whole mud Ca (C/Conv) (mg/L)	719.00	734.00		
CaCl2 wt (%)	2.26	2.60		
NaCl wt (%)	1.36	1.48		
CaCl2 (mg/L)	23167.30	25710.82		
NaCl (mg/L)	13940.53	15203.71		
Brine density (ppg)	8.55	8.58		
Brine density (sg)	1.02	1.03		
Electrical stability (V/dl)				
Water activity (Aw)	0.98	0.98		
LCM (lb/bbl)				

INVENTORY AND COST

Product	Price ($)	Initial	Rec	Final	Used	Cost ($)
Oil Dry	15.55	40	0	40	0	0.00
ALUMINUM STEARATE	80.00	0	0	0	0	0.00
XYZ BAR	10.00	200	0	187	13	130.00
XYZ BX	20.00	0	0	0	0	0.00
XYZ DF-2	350.85	17	0	15	2	701.70
XYZ DRILL N	100.00	0	0	0	0	0.00
XYZ OW	1000.00	2	0	1	1	1000.00
XYZ P	100.00	3	0	3	0	0.00
XYZ Pearl	100.00	90	0	90	0	0.00
XYZ Spar (Cyan)	20.00	0	0	0	0	0.00
Benolone 38	150.00	40	0	40	0	0.00
BULK BAR	155.55	36	23	49	10	1555.50
CaCl2	33.35	190	0	190	0	0.00
CALCIUM CARB	88.55	0	0	0	0	0.00
CARB MED	22.27	40	0	40	0	0.00
Desco	95.15	0	0	0	0	0.00
FLO THIN HT	140.25	0	0	0	0	0.00
GRAPHITE	60.54	40	0	40	0	0.00
LIME	10.89	100	0	80	20	217.80
MICA	15.25	120	0	120	0	0.00
Oil Mud Loan	2.00	0	0	0	0	0.00
SAPP	100.00	8	0	8	0	0.00
SODA ASH	15.05	0	0	0	0	0.00
WALNUT	20.00	0	0	0	0	0.00
WT22	95.96	0	0	0	0	0.00
XYZ BB SOAP	54.20	0	0	0	0	0.00
XYZ GEL	10.10	0	0	0	0	0.00
XYZ MULS	900.98	4	0	4	0	0.00
Pallet	19.50	10	0	10		0.00
Wraps	17.50	7	0	7		0.00
Trucking	1.00					0.00
Engineer 24 Hr	750.00				1	750.00

Mud type	Oil	MW	15-16	Viscosity	45-65
API filtrate	6-18	HPHT filtrate	< 20	pH	9 - 10

Product ($)	Sub total ($)	Tax ($)	Daily total ($)	Pre. total ($)	Cum. total ($)
3605.00	4355.00	342.48	4697.48	85246.30	89943.78

RECOMMENDED TOURTREATMENTS

ENGINEER on Location;

1. Adding diesel and/or water as needed for WI.
Dilution and viscosity control.

2. XYZ Mul P & S for emulsification

3. DF-02 to reduce HTHP

4. Lime to maintain excess of 3 to 5 ppb

Run centrifuge as needed to control LGS and recover barite;

REMARKS

Drill from 14,172' (11,209') to 14,944' (11,178'). Circulated hole clean and pumped slug. Pull to the shoe to change out MWD.

ADDITION (bbl)		LOSS (bbl)		VOL. TRACK (bbl)		FANN	
Other mud		Cuttings	36	Start vol.	1068	600	81
Diesel	54	Seepage		Daily addition	133	300	48
Water	14	Dump		Daily loss	101	200	
Products	65	Shakers		From storage	100	100	
From trac ink		Centrifuge		To storage	0	60	
		Other	65	End vol.	1200	90	
		Pit cleaning		Received	6		
				Returned	3		9

ANNULAR HYDRAULICS

Section (in)				
Sect. length (ft)	10385	3816	461	282
Ann. vel. (ft/min)	209.0	196.4	235.3	836.2
Crit. vel. (ft/min)	304.4	298.3	326.9	744.0
Crit. rate (gpm)	335.5	349.5	320.1	204.9
Eff. tib. (cP)	52	54	48	24
Flow	Lam	Lam	Lam	Tur
EC D (ppg)	16.53	16.51	16.52	17.66
P. drop (psi)	564	190	33	505
Slip vel. (ft/s)	20.4	20.3	20.7	23.1
CTR (%)	90.24	89.69	91.18	97.24
CCI	Good	Good	Good	Good

BIT HYDRAULICS

No. of nozzles	7
TFA (in2)	0.537
Nozzle vel. (ft/s)	137
Impact force (lb)	2.50
D P bit (psi)	258
H HP bit (HP)	34.8
HSI	0.56
Sys. HHP (HP)	447.1
Sys. HHP (%)	7.71
BH ECD (ppg)	16.52

TIME DISTRIBUTION

Rig up / Service	0.50
Drilling	16.00
Circulating	
Tripping	3.50
Surveys	
Logging	
Run casing	
Testing	
Cementing	
Coring / Reaming	
Other	4.00

SOLIDS ANALYSIS

Low gravity (%vol)	5.72
Low gravity (lb/bbl)	53.04
High gravity (%vol)	27.17
High gravity (lb/bbl)	400.36
Drill solids (%vol)	
Drill solids (lb/bbl)	
BG/Bent ratio	
Avg. SG of solids	3.94

MUDPRO PVT

Fig. 4 – A sample of daily mud report

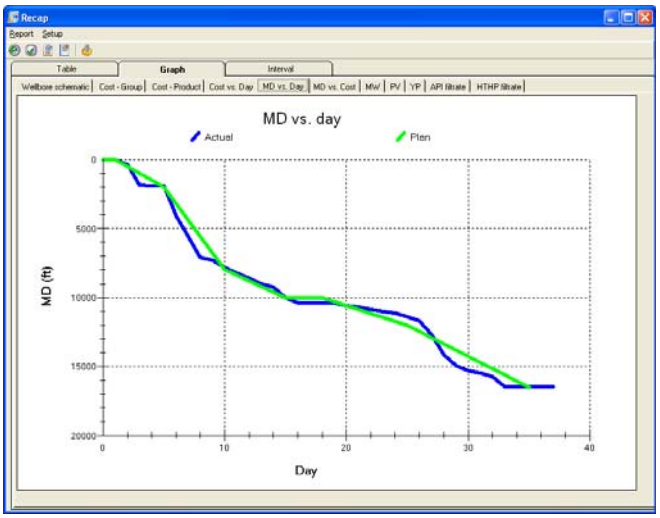


Fig. 5 – Planned vs. actual data

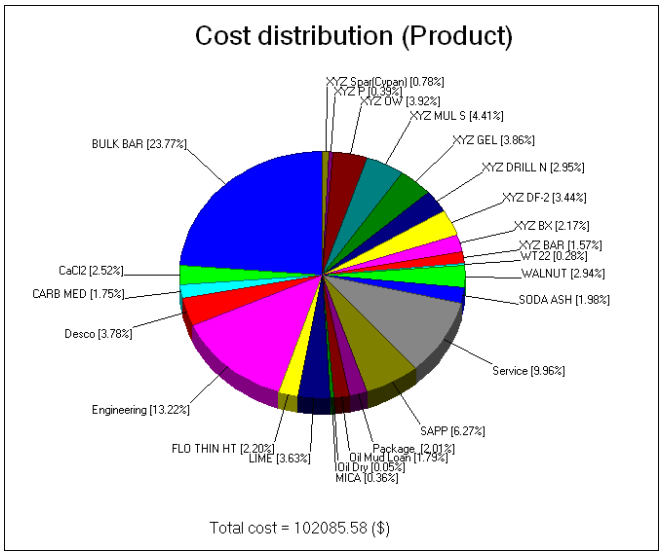


Fig. 6 – Cost distribution pie chart

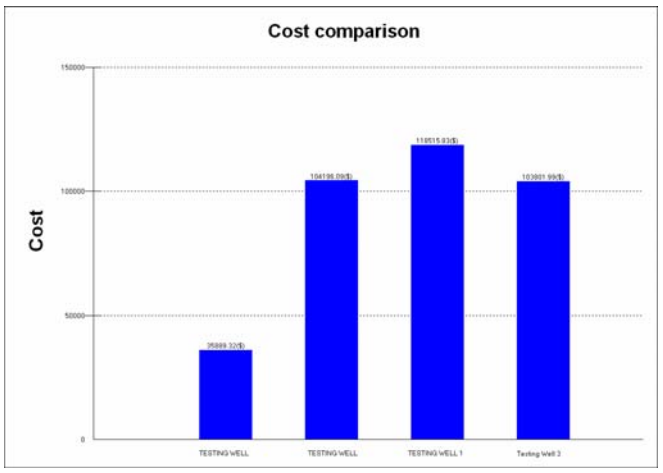


Fig. 7 – Cost comparison chart

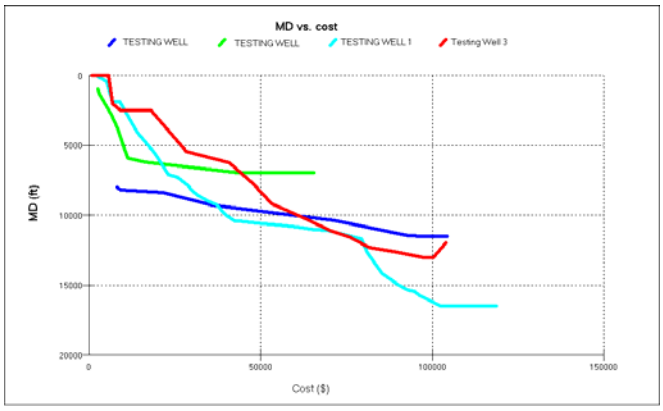


Fig. 8 – Cumulative cost comparison