Closed-Loop Drilling Case Studies

CASE 1: Prima Energy's Cost-Benefit Analysis[1]

Prima Energy Corp. has drilled more than 68 wells in Colorado[2] using a highly automated closed-loop system, which the company started developing along with Nabors Drilling USA, Inc. in 1993. The company found that the economics of drilling these wells in Colorado were best if drilling required less than 12 days. The following table outlines the cost benefit of closed-loop drilling systems.

	Conventional rotary drilling with reserve pit		**Closed-loop drilling with mud motors and diamond bits (50 wells)**	
	Amount	Cost	Amount	Cost
Water	6,400 barrels	$ 4,720	1,200 barrels	$ 1,350
Location	300 x 300 feet	$ 3,000	200 x 150 feet	$ 900
Mud		$ 2,000		$ 1,700
Surface Damages		$ 3,500		$ 2,500
Berm		$ 1,000		0
Mud Haul		$ 2,800		$ 900
Dewatering Unit *		0		$ 8,250
Total		**$17,020**		**$15,600**

* Dewatering cost includes rental of unit, labor, extra fuel, polymer and acid, linear motion shaker, centrifuge, trucking, end loader and miscellaneous costs.

Prima Energy's Calculated benefits of closed-loop drilling:

- cost savings of $1,320 per well
- water savings of 5,200 barrels (closed-loop drilling used 80% less water)

CASE 2: Comparing closed loop drilling to a conventional system: A tale of two wells[3]

Closed-loop systems employ a suite of solids control equipment to minimize drilling fluid dilution and provide the economic handling of the drilling wastes. For one company, a typical closed-loop system includes a series of linear-motion shakers, mud cleaners and centrifuges followed by a dewatering system. The combination of equipment typically results in a "dry" location where a reserve pit is not required, used fluids are recycled, and solid wastes can be landfarmed, hauled off or injected downhole.

Two wells, drilled only 200 ft apart in Matagorda County, TX, provided a unique opportunity to compare the cost savings difference between conventional solids-control equipment and the company's closed-loop system. Both wells drilled through the same formations, using the same rig crew, mud company and bit program.

The closed loop system with improved solids control resulted in some significant savings:

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[1] Longwell, John and Hertzler, Glenn. (Prima Energy Corp. and Nabors Drilling USA, Inc., respectively). 1997. "Closed-loop system as a cost effective alternative to reserve pits," presented at the *Advances in Drilling Technologies for the North American Rockies Conference* (April 28, 1997, Denver, CO)

[2] Interstate Oil and Gas Conservation Commission. 1999 Chairman's Stewardship Award report. www.iogcc.state.ok.us

[3] www.miswaco.com/More_Info/About_Us/98131.pdf

- 43% savings in drilling fluid costs
- 23% fewer rotating hours
- 33$ fewer days to drill to a comparable depth
- 37% reduction in the number of bits used
- up to 39% improvement in the rate of penetration

CASE 3: Reducing waste volume and costs using closed-loop systems[4]
Challenge— Challenges associated with conventional reserve pits include volume of drilling wastes; drill site installation and restoration costs; pollution of land and/or surface water due to failure of pits and/or containment system and associated cleanup costs; and potential for subsurface pollution due to downward migration from pits and/or surface soil permeability.

Solution— Use closed-drilling pit system to reduce volume of drilling waste. The drilling contractor maintained "safe pit levels" and recycled drilling fluid to minimize pit volumes and disposal requirements. Waste management costs due to procedures other than those specified were also the responsibility of the drilling contractor. Cost savings provided the incentive to implement and maintain proper procedures to minimize waste generation in the closed-loop system.

	Conventional reserve pit	**Closed-loop drilling fluid system**
Surface disturbance	reserve pit (235' x 77' x 5') cuttings pit (20' x 10' x 5') water pit (40' x 10' x 5')	No reserve pit necessary.
Total drilling mud and wastes in pits	16,625 barrels	1,100 barrels
	Total reduction in drilling mud and wastes in pits using closed-loop drilling	**15,625 barrels**

Benefits— The following benefits were realized:
1. Total estimated cost savings (considering reduced costs for drill site installation, fluid hauling and disposal, dirt work, and surface damage payment): $11,000.00
2. Reduced surface disturbance by 18,000 square feet (0.4 acres).
3. Reduced drilling mud and wastes in pits by 15,625 barrels.
4. Reduced potential for environmental impact to surface and groundwater.

CASE 4: Closed Loop Drilling Fluid System[5]

Problem— A small independent operator was concerned about the volume of drilling waste in conventional reserve pits at his drilling locations. Waste management costs were a concern, as well as the costs associated with impact on adjacent land due to pit failures. The operator was concerned about the potential for surface water or ground water contamination and the associated potential liabilities.

Solution— The operator was drilling relatively shallow wells in normally pressured strata. Because the drilling plan was relatively simple, the operator investigated the feasibility of using a closed-loop drilling fluid system for these wells. The use of a closed-loop system eliminated the need for a conventional reserve pit. The operator negotiated with drilling contractors to obtain a turn-key contract that required the drilling company to use a closed-loop system and take responsibility for recycling the waste drilling fluid.

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[4] New Mexico Oil Conservation Division. *Pollution Prevention Best Management Practices for the New Mexico Oil and Gas Industry.* http://www.emnrd.state.nm.us/ocd/
[5] Railroad Commission of Texas. *Waste Minimization - Case Histories - Drilling Operations.* http://www.rrc.state.tx.us/divisions/og/key-programs/ogkwchdo.html

Benefits— The turn-key contract was incrementally more expensive. However, because of reduced drill site construction and closure costs; reduced waste management costs; and reduced surface damage payments, the operator realized a savings of about $10,000 per well. Also, the operator reduced the potential for environmental impact and associated potential liability concerns.

CASE 5: Closed-loop system helps reduce drilling waste[6]

A large oil and gas production company used a number of pollution prevention techniques, including closed loop drilling, to drill an exploratory well adjacent to the Tishomingo Wildlife Refuge in Johnston County, OK. The well was drilled on land owned by the U.S. Army Corps of Engineers. Some of the measures taken in drilling the well included:

- Using a closed-loop mud system that allowed for reuse of drilling fluids and use of smaller quantities of water for dilution of the mud to control viscosity and density
- Use of compressed air as the drilling fluid where possible, which allowed for the use of smaller quantities of water and drilling fluid
- Using a smaller casing, which allowed for the use of a 25% smaller hole. This generated a smaller volume of drill cuttings and required less drilling fluid

Savings and Benefits— The hole-size reduction, use of air drilling and closed-loop system reduced wastes by close to 1.5 million pounds. A material and disposal cost savings of $12,700

[6] Oklahoma Department of Environmental Quality. *Pollution Prevention Case Studies.* http://www.deq.state.ok.us/CSDnew/P2/Casestudy/oxyusa%7E1.htm