Overview of RPSEA-AEC-KGS Project

“Enhancing oil recovery from mature reservoirs using a lateral and gamma ray sensor”

Project Start: August 25, 2008
Project End: August 24, 2011
DOE Contribution: $248,385
Performer Contribution: $271,056
Contact Information:
RPSEA – Martha Cather (prc.nmt.edu or 575-835-5685)
Industry Partner – American Energies Corporation, Alan DeGood, President
NETL – Chandra Nautiyal (Chandra.Nautiyal@netl.doe.gov or 281-494-2488)
University of Kansas – W. Lynn Watney (lwatney@ku.edu or 785-864-2184)
Saibal Bhattacharya (saibal@kgs.ku.edu or 785-864-2058)

Evaluate project performance. Researchers will compare incremental oil recovery with the costs of drilling, pumping, and water disposal and analyze the overall economics of the methodology. A “best practices” guide will be prepared to help other producers interested in applying this approach in: 1) evaluation of lateral production wells through refined geomodel development and reservoir simulation and 2) recompletion strategies using laterals to increase production in high volume, high water cut mature oil reservoirs..

Evaluate recovery potential the remainder of Unger Field. Researchers will assemble and analyze logs, cuttings, and well completion and production histories from the rest of Unger Field and history match production/pressure history via simulation studies. They will evaluate the potential for incremental oil recovery via the demonstrated methodology in Unger field wells. Projected water production rates for maximum oil recovery will be estimated. An economic evaluation of the projected costs and incremental revenue will be completed.

Technology Transfer. Throughout the duration of the project all of the results and information collected, including the analyses and final reports on each task, will be made publically available.
LAWRENCE—Kansas Geological Survey researchers at the University of Kansas, in conjunction with industry partners, will be drilling horizontally in search of oil in a Central Kansas field not found through traditional methods.

The project is partly funded by the nonprofit consortium Research Partnership to Secure Energy for America (RPSEA).

The Unger Field in Marion County has produced 8.6 million barrels of oil since its discovery in 1955, but production has declined in recent years. Working with several companies, including Wichita-based American Energies Corporation, the Survey is searching for pockets of remaining oil missed through infill drilling, where vertical wells are drilled between existing wells.

“Based on rough estimates of initial reserves, at least 60% of the initial reserves may remain unproduced in this reservoir,” said Survey geologist Lynn Watney. “Variable production in some of the existing wells suggests that this carbonate reservoir is compartmentalized and that pockets of oil likely remain untapped or under produced.”

Horizontal drilling is a relatively new concept in Kansas. The borehole will be drilled vertically for about 2100 feet then veer off gradually through the Hunton dolomite, a known oil-producing layer, where the researchers hope to encounter oil trapped in undrained compartments.

(continued on next page)
Using modern azimuthal natural gamma ray and geosteering tools, the researchers will obtain data about the nature of the rocks surrounding the drill bit that will help them maneuver the lateral borehole through the upper portion of the reservoir where the remaining oil is expected to reside. Logging tools will then be pushed through the lateral to record porosity and water saturation so that the researchers can estimate the amount and location of remaining oil. If sufficient reserves are found, a downhole pump will be installed to produce the oil.

“Besides aiding drilling and completion, these tools will help refine the existing reservoir geomodel for the field and enable simulation studies to predict recovery from the newly drilled well and assess other opportunities to develop remaining oil from the field,” said Survey petroleum engineer Saibal Bhattacharya. “Lessons learned from this project will be shared with the Kansas oil and gas producers through technology transfer workshops.”

Other industry partners for the project include Tres Management, Pan American Drilling Services, C&G Drilling, Mud-Co, Consolidated Oilwell Services, Weatherford Logging Services, Patterson Rental Tool, and Pason Systems. Drilling is expected to commence in early December and should take about two weeks to complete.

“We hope that success in this project will encourage new drilling to reinvigorate other mature oil fields in Kansas,” Watney said.

Funding for the project is provided through the “Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program” authorized by the Energy Policy Act of 2005. RPSEA, a consortium of research institutions, energy producers and energy consumers, is under contract with the U.S. Department of Energy’s National Energy Technology Laboratory to administer several elements of the program.

Story by Cathy Evans, 785-864-2195

For more information, contact Lynn Watney, 785-864-2184
Unger Field
Marion County, Kansas

American Energies Corporation
Alan DeGood

KU Geological Survey
The University of Kansas
Overview

- The Unger Field, discovered in 1955, has produced 8.6 MBO. While 76 wells produced in 1966, only 16 are producing at an average rate of 2.2 bbls per day. Wells have variable production rate over crest of structure and wells near original oil:water contact are still producing suggesting considerable heterogeneity of the reservoir and opportunities in infill drilling and lateral to be drilled in this project.
- The new lateral, American Energy Corporation’s Slocombe-Rood #1-19 is programmed as a 2100’ horizontal that will be enter the upper most portion of the Hunton Group dolomite oil reservoir that subcrops beneath a regional (Kaskaskia) unconformity.
- Lateral will be guided along the crest of a northwest trending anticline located in the southern part of Unger Field using real-time geosteering.
- The thickness of net pay (porous dolomite) in the Hunton ranges from 12 ft to 25 ft. The reservoir lithology consisting of karsted, fractured, and vuggy dolomite.
- Total thickness of the dolomite interval in the vicinity of the lateral ranges from over 60 ft on the south to around 20 ft on the north. Thinning is due to progressive northward truncation along its top along the unconformity. The northwest trajectory of the lateral will follow the uppermost porous reservoir as it undergoes northward truncation. Micrologs available in adjoining wells indicate progressive subcrop of gently southward dipping internal flow units.
- The Hunton reservoir is overlain by a thin, tight (5-10 ft) dolomitic caprock, which in turn lies beneath a ~150 ft interval of Kinderhook and Chattanooga Shale. The lower portion of the Chattanooga Shale has elevated natural gamma radiation.
- The Hunton reservoir is underlain by a thick section of Maquoketa Shale.
- Lateral is being drilled to contact isolated or underproduced compartments of fractured, vuggy dolomite. Hunton in area of the lateral has produced under a strong edge-water drive (water encroachment is along the edges of reservoir).
- The tight dolomitic caprock will aid in keeping the lateral moving through the more easily drilled porous reservoir. The elevated gamma ray of the Chattanooga Shale will also help
- Utilizing geologic data from nearby wells combined with the radial gamma ray tool, the lateral will be guided along the upper most portion of porous Hunton dolomite.
Staff/affiliations

• American Energies Corporation
  – Alan DeGood, President
  – Doug Davis & Karen Houseberger – geologists
  – Jake Segal -- field superintendent

• Kansas Geological Survey
  – Saibal Bhattacharya -- petroleum engineer
  – Jason Rush -- geologist
  – Lynn Watney – geologist
  – John Doveton – log petrophysics
  – David Newell – geologist

• Tres Management, Inc.
  -- Brad Crouch
Drilling team

 Contractor: C & G Drilling Rig 2
 Eureka, KS
 Tim Gullick
 620-583-4306

 Mud Services: Mud-Co / Service Mud Inc.
 Wichita, KS
 316-264-2814

 Cement Services: Consolidated Oilwell Services
 Larry Storm, KS
 620-323-3381

 Open Hole Logging: Weatherford
 Oklahoma City, OK
 405-720-4334
 Mark Houpe

 Directional Services: Pan American Drilling Services
 Oklahoma City, OK
 405-677-6800
 Mark Greene  405-620-7128

 Rental Drill Pipe: Patterson Rental Tool
 Oklahoma City, OK
 405-810-9300
 Mark Tayar  405-401-4900

 Electronic Monitoring: Pason Systems USA
 Lafe Coldwater  580-551-9470
 Chase Coldwater  405-334-7525
Horizontal Well
American Energies Corporation
Slocombe-Rood #1-19
Unger Field
Marion County, Kansas
Well located approximately 3 miles northwest of Peabody, Ks.
Peabody is 55 miles west of Emporia on U.S. Highway 50.
To get to the Rood on roads that are not bad. Nighthawk(blacktop) /90th. East ½ mile. Go west on 90th 2 miles to Limestone. Go North 1 mile to 100th rd and then East ½ mile. Lease rd on S. side of road.

Slocombe-Nighthawk and 90th. Go West 1 ½ miles and then North into.
To get to the Rood on roads that are not bad. Nighthawk (blacktop) / 90th. East ½ mile.
Go west on 90th 2 miles to Limestone. Go North 1 mile to 100th rd and then East ½ mile.
Lease rd on S. side of road.
Slocombe-Nighthawk and 90th. Go West 1 ½ miles and then North into.

AEC Slocombe-Rood #1-19
Unger Field Marion County, Kansas

Location of lateral

Focus: Section 19
Unger Field Production

Field discovery: 1955
Cum. 8.6 million bbls.
2008: 13,572 bbls., 17 wells
2.2 BOPD/well
Misener Ss. and Hunton Ls.
~2800 ft (md)
Intent to Drill

For NCG Use Only

KANSAS CORPORATION COMMISSION
OIL & GAS CONSERVATION DIVISION

NOTICE OF INTENT TO DRILL

This form must be signed.

All names must be in block letters.

IN ALL CASES PLOT THE INTENDED WELL ON THE PLAT BELOW.

In all cases, please fully complete this side of the form. Include lines 1 through 9 at the bottom of this page.

OPERATOR: American Energies Corporation

Lease: Mount Acadia

Well Number: 1-18

Rng: 19

Number of Acres: 1.0

GEOGRAPHIC LOCATION:

N 00° 00' 00"
E 00° 00' 00"

PLAT

Show location of the well. Show footage to the nearest 0.01 unit or boundary lines. Show the actual locations of lease lines, tank batteries, pipelines and electrical lines as required by the Kansas Surface Order Notice Act (K.S.A. 60-2022).

Informative notes to the surface operator.

PLAT

For NCG Use ONLY

 purported by: NCG - Conservation Division, 130 E. Market - Room 270, Wichita, Kansas 67202

Form must be signed.

All names must be in block letters.

For NCG Use Only

AMT: $15,0000

Minimum Surface: 10 Acres

Approval date: 12/28/2010

Submitted Electronically

NCG reference: 2445061

21 3

Plotted:

2

Wells will not be drilled or permit expired. Date:

Signature of Operator or Agent

31

For NCG Use Only

NCG-Conservation Division, 130 E. Market - Room 270, Wichita, Kansas 67202

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<th>Acres</th>
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NOTE: All notes locate the cost of the proposed drilling location.

In plotting the proposed location of the well, you must show:

1. The manner in which you are using the duplicate plot by identifying section lines, i.e., section 1, section 2, section 3, etc., extending 40 acres, etc.

2. The distance of the proposed drilling location from the south (north) east (west) north (south) east (west) line.

3. The distance from the nearest well to the new well location.

4. If proposed section is located within a pipeline or proposed field, a certificate of assurance that must be attached.

5. The coordinates of lease, pipeline, road, and easement lines.

6. The proposed location of lease lines, tank batteries, pipelines, and electrical lines as required by the Kansas Surface Order Notice Act (K.S.A. 60-2022).

7. Any other information that may be of assistance.

8. The location of any existing wells.

9. The wells that are subject to the proposed drilling location.

10. The location of any existing pipelines, roads, and easements.

11. The location of any existing wells.

12. The location of any existing pipelines, roads, and easements.

13. The location of any existing wells.

14. The location of any existing pipelines, roads, and easements.

15. The location of any existing wells.

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23. The location of any existing wells.

24. The location of any existing pipelines, roads, and easements.

25. The location of any existing wells.

26. The location of any existing pipelines, roads, and easements.

27. The location of any existing wells.

28. The location of any existing pipelines, roads, and easements.

29. The location of any existing wells.

30. The location of any existing pipelines, roads, and easements.

31. The location of any existing wells.
Intent to Drill (continued)

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<th>Operator Name:</th>
<th>American Energies Corporation</th>
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<tr>
<td>License No:</td>
<td>1396</td>
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<tr>
<td>Operator Address:</td>
<td>155 N MARKET STE 710</td>
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<tr>
<td>WICHITA KS 67202</td>
<td></td>
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<tr>
<td>Contact Person:</td>
<td>Karen Housenberg</td>
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<tr>
<td>Phone Number:</td>
<td>316-263-6755</td>
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<th>Lease Name &amp; Well No:</th>
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<td>1-19</td>
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<td>Pit Dimensions:</td>
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<td>Depth from ground level:</td>
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- **Type of Pit:** Drilling Pit
- **Distance to nearest water well:** 450 feet

- **Emergency, Cutting, and Burning:**
  - **Type of Material:** None
  - **Number of Operating Wells:** 2
  - **Tanks:** None
  - **Drills:** None

- **Abandonment:** Let dry, restore location to original
- **Dirt Site:** Must be closed within 300 days of stated date

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**KCC OFFICE USE ONLY**

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<td>Lease Inspection:</td>
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**Submitted Electronically**
Intent to Drill (continued)
**Contact Information**

American Energies
155 N. Market, Ste 710, Wichita KS 67202
Home 316-794-8391; H Fax 2997, call 620-242-6301
Prepared 1-6-11
Phone 316-263-5785; 316-263-1851
Fax 620-382-3465

**Slocombe-Rood 1-19**

- **County:** Marion
- **S-T-R:** 19-21-3E
- **Location C NW 5E**
- **Spotted:** 1650fnl
- **Bottom hole:** 1650fnl, 1,750fwl - KCC notified of chg
- **Plug Down:** 1650fnl, 1,750fwl - KCC notified of chg
- **Elev:** 1421' elevation
- **Survey:** Central Survey 620-762-7554
- **End of directional hole:** 1650fnl & 1750fwl
- **E2 NW Sec 19 Rood Lease:** Fee Owner: The Lavonne Hannaford Trust
- **Marion KS 66861:** c/o Roger W Hannaford 222 E Main
- **Tenants:** Charles W Seifert Use our lease road will rebuild winery
- **Double S Farms & Cattle LLC:** 620-382-2027
- **Hillsboro KS 67003:** 620-947-3890
- **P. Cookeley checked location 11-9-2010**
- **Spud spud est 1/7/2011**
- **S. Casing:**
- **Geologist:** Doug Davis W-3162635785; cell 316-641-4468; home 316-722-7196
- **KGS Lynn Watney:** 785-864-2184, 5317fax, 785-640-4852; cell lwatney@kgs.ku.edu
- **KGS Saibal Bhattacharya:** 785-864-2058; kgs.ku.edu 5317 fax; saibal@kgs.ku.edu
- **Open hole now 2100' (was 3200-4700' 6-1/8")**
- **Driller:** E & G Drilling Co., Euerka 620-583-5318;
  - **Tim Guick 620-583-4306** cell Rig 2
- **Directional Pan American Drilling Okla City 405-677-6800,**  
  - **Mark Greene 405-620-7128**
- **Right RTD:** TVD Horizontal in Hunton
- **AEC Field Supr Galen Jones 620-242-6098** Wtr well, pits, pipe racks - will do
- **KoOne Call C & G will call**
- **S. Casing fr 9-5/8'' 36# 250'' STC & New Rg 3 Texture LS**
- **National Bob Bass 262-457**
- **P. Casing fr 2 23/8'' 3136 National LT&C New Rg 3 255 API**
- **National Bob Bass 262-457**
- **Open hole 2100' 6-1/8' corrected**
- **Consolidated Larry 9805 620-323-3386**
- **Mud Mud-Co. Chuck Latham 316-264-2814; 5024 Fax**
- **KCC 337-6200**
- **Log Tech:** Send in Application 11/8/10
- **Wichita Eagle Fax to "Ro" with contact info 269-6767 will be published 11/23
- **Starr 793-2146**

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To get to the Rood on roads that are not bad. Nighthawk (blacktop) /90°. East ½ mile.
Go west on 90° 2 miles to Limestone. Go North 1 mile to 100° rd and then East ½ mile.
Lease rd on S. side of road.

\[ Drilling Intent.xls \]

Slocombe-Nighthawk and 90°. Go West 1 ½ miles and then North into.
Surface Topography

Surface Location: (CNWSE) 1878 fsl & 1750 fwl, Section 19-T 21S- R3E
2100 ft open hole lateral
# Horizontal Well Trajectory

**Company:** American Energy Corporation  
**Well:** Unger Field  
**Location:**

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<th>Surface Location</th>
<th>MD (feet)</th>
<th>Inclination (degrees)</th>
<th>Azimuth (degrees)</th>
<th>TVD (feet)</th>
<th>N-S (feet)</th>
<th>E-W (feet)</th>
<th>DLS (deg/100')</th>
<th>VS @ 320.90° Az (feet)</th>
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Map view of lateral, Section 19
AMERICAN ENERGIES CORPORATION
Slocomb #7H
Marion County, KS
Operator: American Energies Corporation
155 North market Street, Ste 710
Wichita, KS 67202

Well Name: Slocomb #7H
Surface Location  Bottom Hole Location
1873’ FNL, 1444’ FEL   1160’ FNL, 1913’ FWL
Section 19 –21S – 3E  Section 19-21S-3E
Marion County, KS   Marion County, KS

Projected TD:  2,815’ TVD
4,915’ MD

Elevation: Surface Elevation: ’
Kelly Bushing Elevation: ’

Primary Objective: Hunton
# Casing Program

<table>
<thead>
<tr>
<th>Depth</th>
<th>Hole Size</th>
<th>Casing</th>
<th>Burst psi</th>
<th>Collapse psi</th>
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<tbody>
<tr>
<td>0 – 250’</td>
<td>12 1/4”</td>
<td>9 5/8” 36# J-55 ST&amp;C</td>
<td>1730 psi</td>
<td>770 psi</td>
</tr>
<tr>
<td>0 – 3,130’</td>
<td>8 3/4”</td>
<td>7” 23# J-55 LT&amp;C</td>
<td>4980 psi</td>
<td>4320 psi</td>
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<tr>
<td>3,200’ – 4,700’</td>
<td>6 1/8”</td>
<td>Open Hole</td>
<td></td>
<td></td>
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</table>
PRE – SPUD PREPARATION:

• Construct location, reserve pit, working pits, and road to accommodate rig plus up to 3 additional living quarter trailers.
• Hold pre-spud meeting with operating, rig, and key vendor personnel. Review drilling plan, scheduling, and safety policies. American Energies expects all operations to be conducted with safety as a priority. Operations are to be suspended if necessary to provide safe working conditions.
INTERVAL: Surface to 250’

- Drill 12 1/4” hole to 250’. Bottom hole assembly; mill tooth bit, bit sub, and 6 ¼” collars. Spud with 35+ viscosity, pump hi-vis sweeps with cotton see hulls for hole cleaning. Maximize pump flow rate (6 ¼ x 14, 7.06 gal per rev,). Short trip to bit, condition hole for casing.
- Run 9 5/8” 36# J-55 casing with 4 centralizers, utilizing landing joint. Strap weld bottom two connections. Wash casing to bottom and circulate minimum one casing volume prior to cementing. Cement with 140 sx Regular, 2% gel, 3% CaCl, .5% flocele. Drop wiper plug and displace to 220’+/−, shut in and WOC.
- WOC 4-6 hours. Back out landing joint, screw in adapter and nipple up annular BOP. Test annular and casing to 500 psi.
INTERVAL 250’ – 2,100’ – Straight Hole

- Take surveys at 500’ intervals. Desired pump rates in the 400-500 gpm range. At kickoff, circulate hole clean and trip out for directional tools. If hole conditions dictate, be prepared to return to bottom to condition prior to running directional tools.
INTERVAL: 2,100’ – 3,130’ MD – Build Section

- Pick up 8 ¾” insert bit, bent housing motor (1.8 – 2.12 deg bend), float sub, MWD with gamma ray, monels, 900’ drill pipe, 12 drill collars, jars, 3 drill collars, and remainder of drill pipe. Trip in hole taking directional surveys at 500’ intervals. Determine actual bottom hole location and make well plan adjustments as needed. Initial build rate will be 8 degrees per 100’, increasing to 12 degrees following a 100’ tangent at 45 degrees, all at a 313.7 deg. azimuth.

- Maintain 300+ gpm and 45-55 viscosity for hole cleaning. Add LCM only as needed. Should it be necessary to carry LCM through the curve, determine in advance with directional personnel the preferred blend of LCM best suited for optimum tool performance. Difficulty sliding is often related to hole cleaning. Monitor solids at the shaker in an attempt to determine if cuttings removal is efficient for current P-rates. Hi-vis and/or lo-vis sweeps and short trips should help in hole cleaning. Additions of soltex, powdered graphite, and various ‘lubricants in a drum’ are often required to improve sliding performance.

- Casing point target is at 3130’ MD, 2815’ TVD at angle of 89.96 degrees. Condition hole for casing. In the event of excessively tight hole conditions trip out, lay down directional tools, pick up an under gauge reamer at 30’ and ream the curve. Lay down 4 ½” drill pipe and collars. Run 7” 23# J-55 casing with guide shoe and float collar on top of first joint. Calculate cement for 1000’ fill, or to kickoff point, plus 40% excess. Circulate minimum one casing volume prior to cementing. Cement with 10 bbl fresh water spacer followed by 185 sx Thick Set, 8 lb/sx gypseal, 8 lb/sx salt, 4% gel, 2% CaCl mixed at 14.8 ppg, 1.68 yield. Displace cement with fresh water.

- Pick up BOP, set slips with 7” in full tension. Install 5 ½” pump liners. Nipple up BOP. Test BOP and casing to 500 psi with rig pumps.
INTERVAL: 3,130’ – 4,915’ MD – Lateral Section

- Pick up 6 1/8” PDC, 4 3/4” - 1.8+/- slow-speed motor, float sub, MWD with focused gamma ray, 2- flex monels, 1500’ 3 ½” 13.3# S-135 drill pipe, 34 joints 3 1/2” hevi-weight DP, jars, 6 joints HWDP, and remainder of 3 ½”. Drill cement and shoe

- Drill lateral at 200+ gpm. Monitor solids removal versus P-rate and torque and drag changes for indicators of improper hole cleaning. Directional plan is Trip as necessary for pipe swap to insure HWDP stays in the straight hole. Bit records from wells in Woods County indicate relatively short bit runs in the lateral (50 hours in 8 3/4” hole size) due to chert content. Expect 30-40 hour runs in 6 1/8” size under similar conditions with IADC 537 or 547 bits. Evaluate dull bit condition for possible PDC run (especially in the front part of the lateral) or diamond enhanced gauge row protection due to increased chert composition.

- At total depth, condition hole for logging. If necessary, trip out, lay down directional tools, and make additional conditioning trip prior to drill pipe conveyed logging operation. (triple combo logging suite)

- Following logging operations, trip in hole with bit and drill pipe. Displace hole with clean fluid. Trip out laying down drill pipe. Rig down, release rig.
Triple Combo Log Suite
ran after lateral is drilled,
pushed through drill pipe

http://www.ldeo.columbia.edu/BRG/ODP/LOGGING/TOOLS/triple.html
Azimuthal Gamma Ray ran while drilling to assist geosteering

Drilling is paused while detector window on azimuthal gamma ray tool is rotated and measurements taken every 45 degrees through 360 degree rotation.
Miscellaneous

• All recommendations (cement, mud, etc) are subject to field adjustments

• All delivery tickets must be priced and signed before AEC will process invoice. Invoices without field signature will be returned to vendor.

• Inventory and report daily fuel usage and deliveries.

• Maintain complete and current rental list.

• Maintain complete drill pipe, drill collar, and casing inventory of all material on location

• Check all casing connections with float equipment, especially the specialty threads, well in advance of running in hole.

• Hold planning meeting with cementer, casing crew, rig pusher, and other critical personnel prior to running the 4 ½” casing.

• Insure safety meetings are held prior to all casing, cementing, and other planned operations. Observe regularly scheduled safety meetings held by the rig personnel. Record all occurrences on daily report. Post emergency phone listing on rig floor, and in pusher and company man trailers.
Geology
Hunton Structure – south Unger Field

Geology by Gerry Honas

Trajectory of the lateral --
Green dashed – NE side of NW-SE trending anticline (away from fault-bounded SW flank of anticline)

Section 19
Hunton isopach – south Unger Field

Geology by Gerry Honas

Trajectories of the lateral - 
Green dashed – NE side of 
structure crossing rapidly thinning 
Hunton dolomite were reservoir 
flow units are subcropping
Section 19
Unger Field
Structure map top Hunton Group dolomite well trajectory

cross section index
Contour Interval = 5 ft

Upper blue number = thickness of Hunton reservoir

Original O/W ~-1420 ft

Lateral start: CNWSE
1878 ft FSL & 1750 ft FWL

Lateral bend:
2084 ft FNL & 2452 ft FWL

Lateral end:
1650 ft FNL & 1750 ft FWL
Open hole = 2100 ft

Location of Lateral

DST data from:
Slocombe 5, 6
Mellot 4
Rood 1, 2, 3, 4, 5, 7

Cross section index (slide #35)
Main Fault

(lateral start)
1878 ft FSL & 1750 ft FWL
Top Pay = -1390
MD = 1425 + 1390 = 2815 ft

(lateral bend)
2084 ft FNL & 2452 ft FWL
Top Pay = -1378
MD = 1438 + 1378 = 2816 ft

(lateral end)
1650 ft FNL & 1750 ft FWL
Top Pay = -1390
MD = 1445 + 1390 = 2835 ft

Section 19
Unger Field
Structure Top of Pay, Hunton dolomite and cross section index
Contour Interval = 5 ft
Original O/W ~-1420 ft

Cross section index (Slide #35)
SP-Caliper-Microlog curves shown – SP depicted in color delimiting magnitude

Lateral will follow the upper porous Hunton dolomite (bright green interval) along the crest of the structure. Thin tight dolomite overlie caprock except in vicinity of Rood #4
- Hunton reservoir thins to the north.
- Structural highs are thin, suggest paleostructure contribution
- Tight dolomite caprock above pay ranging from 0-10 ft, thins near Rood #4

900 ft  Vertical Exaggeration = 5x

SP-Caliper-Microlog curves shown – SP depicted in color delimiting magnitude
Section 19
Unger Field
Structure map top Hunton dolomite with
South to northeast cross section index
(cross section next slide)

Upper blue number = thickness of Hunton reservoir
South to Northeast Structural Cross Section

- SP-Caliper-Microlog, neutron curves shown – SP (variable color) and neutron (all purple)
- Lateral passes through this cross section east of Rood #4

Vertical Exaggeration = 3x

- Likely faulted zone
- Window of Lateral
- Tight upper section of Hunton reservoir
- Near fault zone
- ~original O/W

6655 BO, NW State drawdown test
17,800 BO, NW State drawdown test
212 BOPD, NW 8 hrs.
141 BOPD, NW 8 hrs.
Thickness of total porous interval (solid colors) overlain with structure top of pay zone (contour)
Thickness of H1 layer (lowermost flow unit) with structure top of pay zone as contours

- Flow unit H1 thins to the north
- Lateral will be above this layer
Thickness of H2 layer (middle flow unit) with structure top of pay zone as contours

- Middle flow unit H2 thins to the north
- Lateral is projected to intersect this layer east of Rood #4
NW-SE Structural Cross Section
with flow units (H1, H2, H3) of Hunton dolomite reservoir
Additional cross section similar to section in previous slide
Thickness of H3 layer (top most flow unit) with structure top of pay zone as contours

- Flow units inferred from spontaneous potential and micrologs
- Uppermost flow unit H3 thins in narrow band northeast of Rood #2
- Lateral is projected to follow this upper layer except in vicinity of Rood #4
Thickness of H4 layer (off structure flow unit) with structure top of pay zone as contours

- Lateral does not encounter topmost flow unit H4 that is truncated over the crest of the anticline
• Total thickness of Hunton pay along course of lateralrangs from 13 ft on south to over 25 ft east of Rood #4

• Original oil:water column ~40 ft and vicinity of lateral above this oil:water contact
Cumulative thickness of Hunton pay (color fill) overlain by contours of structure top of pay with dip vectors

- Thickness of Hunton pay along course of lateral ranges from 13 ft thick on south to over 25 ft east of Rood #4
- Original oil:water column ~40 ft and vicinity of lateral above this oil:water contact (~1420)
Thickness of H3 layer with structure top of pay zone as contours -- including H3 with H4 in Rood 5 for modeling

- Total thickness of Hunton pay along course of laterals from 13 ft on south to over 25 ft east of Rood #4
- Original oil:water column ~40 ft and vicinity of lateral above this oil:water contact
Reservoir & Well Simulation
(to be accomplished with new log and well test data from lateral)

Grid Dimensions:
Grid cell size: 110x110 ft
Area of grid: 1980 x1980 ft

Input grids:
Structure Top Hunton Pay
Thickness of H1, H2, and H3
Average Ø of H1, H2, and H3; Estimated from micrologs
Average permeability of H1, H2, and H3; Interpolated from Slocombe 3 phi-k plot from core analysis (see next slide for phi-k plot)
Average water saturation, Sw. To be estimated from capillary pressure curves obtained from nearby wells in transition zone. with full log suites

Note: Combined H3 and H4 layers into H3 in Rood 5 since limited area of H4
Phi-k plot used to estimate permeability from porosity

Rough estimate of permeability with dashed red line using nearby/offstructure Slocombe 3 well. Low perm. values suggest vugs with limited connection measured in plug samples.
Estimates of flow unit delineation using available Spontaneous potential & micrologs

Rood #4
SP-Cal-Microlog

Rood #2
SP-Cal-Microlog
Permeability is roughly estimated from micrologs & compared to core & log analysis from Slocombe #3
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<th>Location</th>
<th>Well</th>
<th>Operator</th>
<th>Completion</th>
<th>Elev/KB</th>
<th>Hunton from to BHP</th>
<th>Perf From To</th>
<th>IP Oil</th>
<th>IP Wtr</th>
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NW-SE structural cross section with scanned wells in sec. 19-21s-3w, Unger Field
Slocombe #2  sw nw sw Sec. 19
Unscaled GR and Neutron logs
Effective 3-4 ft.
Slocombe #6  CAL-SP-Microlog sw sw ne Sec. 19
Effective ~25 ft
Upper zone ~13 ft

Good SP deflection (dashed line) and mudcake (positive deflection of Caliper –solid curve) suggest matrix permeable matrix porosity
Rood #4 se se nw 19 CAL-SP-Microlog
Effective ~14 ft.
Upper zone ~6 ft.

Key well immediately west of lateral

Hunton Dolomite

Good SP deflection (dashed line) and mudcake (positive deflection of caliper – solid line) suggest matrix permeable matrix porosity
Rood 7 nw se nw Sec. 19
CAL-Microlog
Effective upper ~11 ft.