PROGRAM TO DETERMINE THE UNIQUENESS OF THREE FORKS BENCH RESERVES, DETERMINE OPTIMAL WELL DENSITY IN THE BAKKEN POOL, AND OPTIMIZE BAKKEN PRODUCTION (BAKKEN PRODUCTION OPTIMIZATION PROGRAM)

QUARTERLY PROGRESS REPORT
OCTOBER – DECEMBER 2013

BACKGROUND

The goal of the Bakken Production Optimization Program being conducted by the Energy & Environmental Research Center (EERC) in close coordination with Continental Resources, Inc. (Continental) and several of the Williston Basin's other premier operating companies is to simultaneously improve Bakken system oil recovery while reducing its environmental footprint. The program is investigating new technologies and approaches to simultaneously increase the understanding of potential petroleum reserves in the Bakken–Three Forks system and decrease recovery costs in an environmentally sound manner.

The anticipated outcomes of the Bakken Production Optimization Program are to increase well productivity and economic output of North Dakota's oil and gas resources, decrease environmental impacts of wellsite operations, and reduce demand for infrastructure construction and maintenance. Specific results will include a) a greater understanding of Bakken–Three Forks reservoirs and subsequent significant increases to estimates of recoverable hydrocarbons; b) less truck traffic, resulting in decreased diesel emissions, road dust, and spills; c) reduced road maintenance costs, wastewater production, disposal costs, and freshwater use; d) reduced land use impacts; and e) increased revenue for the state, royalty owners, and operators from added product streams, captured earlier in the well life cycle.

The following quarterly report summarizes the program activities from October through December 2013.

ACCOMPLISHMENTS DURING REPORTING PERIOD

The following key activities were performed during the reporting quarter:

Phase I – Drilling Wells in the Hawkinson Unit Located in Sec. 22 and 27, 147N-96W

- Conventional core was collected and logs run in a single, deep, vertical pilot hole drilled through the Middle Bakken and Three Forks Formations into the Nisku. Conventional core analysis is waiting on core being slabbed. We are continuing to perform advanced logging petrophysical analysis data integration work.

Phase II – Completion Operations of Eleven (11) New Wells

- Flowback and first production were started for the eleven (11) new wells drilled and completed.

- A vertical seismic profile (VSP) was collected, and ten (10) of the eleven (11) wells were monitored with multiple VSI (versatile seismic imager) tool arrays to record in real time the microseismic events. Schlumberger's final quality control and processing of the microseismic events were initiated. The 10 wells microseismic continues to proceed through Schlumberger's quality control process. The basic interpretation has been initiated on a well-by-well basis. Presently, we are continuing to discuss technical goals of advanced microseismic processing with ESG Solutions.

Phase III – Reservoir Engineering

- Fracture modeling of completion operations was initiated for three (3) existing producers as well as recent completions.

- We are continuing to perform fracture modeling of completion operations for existing producers as well as recent completions.

- Chemical tracer samples were collected from the fracture treatments.

- Postfracture pulse testing was performed to determine initial open-fracture connectivity following flowback.

- Performed petrophysical evaluation of pilot hole logs for determining original oil in place (OOIP) and reservoir properties.

Phase IV – Expansion Applications via 3-D Seismic

- Continental Resources and Dawson Geophysical completed the field acquisition of the 3-D seismic survey's data and delivered it to the processor, Geotrace. 3D seismic processing continues to be work in progress. Preliminary Pre Stack Migration (PSTM) has not been delivered to date.

Phase V – Optimization of Wellsite Operations

In the previous quarter, the EERC provided preliminary scopes of work (SOWs) to program members for review and comment. In this quarter, work was initiated on several of these modified SOWs.

Under the area of flaring mitigation (EERC Task 1 – Hydrocarbon Utilization), two distinct activities were initiated:

- North Dakota Petroleum Council (NDPC) Flaring Task Force/Database Development.

- The EERC created a Web-based information database to house technical and economic information about technologies and services capable of utilizing wellhead gas and improving gas utilization in North Dakota. The database will provide an easily accessible way of matching vendors with particular needs of Bakken oil and gas producers. The following activities were conducted to support the creation of the Flaring Solutions database.

  - A request for information (RFI) was created that provides background information on the quality, quantity, and distribution of gas in North Dakota and describes common conditions that need to be addressed by vendors with flare reduction offerings.

  - A Web-based worksheet and database were created to allow vendors the ability to provide information about their technologies and services.

  - The RFI was released, and 25 organizations have provided information to the database. Work is ongoing to identify additional vendors and add their information to the database.

  - A Web-based interface was also created to allow oil and gas producers the ability to access the database, query data, compare technologies, and identify offerings that match their particular needs.

- The EERC has reviewed technical data provided by vendors and is working with producers and vendors to identify opportunities for demonstration projects that have the potential to improve gas utilization and reduce the risk of implementing new technologies and strategies. Work continues to assess the relative impact individual technologies can have on gas use, thereby decreasing the fraction of flared gas in North Dakota.

- The EERC has participated in the NDPC Flaring Task Force conference calls and provided updates on the progress of the Flaring Solutions database.

- Investigating the Potential for Utilizing Rich Bakken Gas for Enhanced Oil Recovery (EOR) in the Bakken Play – The EERC initiated a laboratory study to evaluate the potential for utilizing rich Bakken gas for EOR in the Bakken.

  - An apparatus for determining minimum miscibility pressure (MMP) using CO_2 and the EERC's new capillary rise technique was modified to allow MMP determinations using natural gas. Initial MMP determinations with pure methane were performed with Bakken crude oil at 110°C and with a conventional crude oil (for comparison) at 42°C (its reservoir T). The MMP for the Bakken crude oil with methane was ca. 6000 psi, approximately double the MMP value of 2950 psi determined using CO_2. The increase in MMP for the conventional oil was more dramatic, with the methane MMP at ca. 5000 psi, while the CO_2 MMP was 1500 psi.

  - Phase calculations have been completed to determine the conditions that can be used to pump mixed methane and natural gas liquids (NGLs) while avoiding condensation of the NGL components.

Under the area of waste management (EERC Task 2), the following activities were conducted:

- Several hundred color glossy copies of the EERC-produced flaring and NORM (naturally occurring radioactive material) fact sheets developed and reported during the previous quarter's activities were sent to NDPC and Oil and Gas Resaerch Council (OGRC) offices at their request and in support of the ongoing informational campaigns of those offices.

- The EERC supported the Bakken NORM waste task force, providing information on field-based radiation measurement technology and perspective on an ongoing Argonne National Laboratory study commissioned by the North Dakota Department of Health (NDDH). A suggested course of action for industry was presented during a task force conference call. Members of the Bakken Production Optimization Program consortium contacted the EERC through NDPC leadership to request analytical support from the EERC that will enhance and verify results of the Argonne–NDDH NORM waste study. The intent of this effort would be to fully cooperate with NDDH to ensure maximum benefit from the Argonne study.

- The EERC began compiling an educational booklet on oil and gas NORM waste, intended for use in an educational campaign among industry personnel, regulatory personnel, and the general public. A draft version of this educational booklet is expected to be ready for program member and OGRC review by the end of February 2014.

Under the area of water management (EERC Task 3), the following activities were conducted:

- The EERC presented on the Bakken Production Optimization Program at the North Dakota Water and Pollution Control Conference (Grand Forks, North Dakota, October 24, 2013), with a focus on water needs for hydraulic fracturing, the challenges related to water recycling and reuse, and an overview of the flare gas mitigation study conducted by the EERC. The slides presented are included in Appendix A.

- EERC personnel reviewed literature and engaged various people from key industry and state stakeholders to better determine the status of water management trends and issues, industry's interest in water recycling and reuse, and emerging technologies to allow for reuse of produced water.

No activities were conducted under the site logistics area (EERC Task 4) during this quarter.

In this quarter, the EERC initiated planning activities under Task 5 – Process Optimization and System Failure Analysis.

- The EERC initiated compilation of a document describing analytical capabilities and in-house expertise to assist members with corrosion and scale diagnostics that could facilitate mitigation strategies.

The EERC was asked to provide preliminary data and format guidance on a fact sheet focused on crude oil transport by rail. The goal of this fact sheet would be to objectively compare Bakken light sweet crude to other flammable commodities transported by rail in North America.

In this quarter, EERC staff met twice with personnel from Hitachi Data Systems to postulate new "big data"-handling upgrades and technology that could facilitate the optimization of Bakken resource development.

MEMBERSHIP AND FINANCIAL INFORMATION

This program is being sponsored by the North Dakota Industrial Commission (NDIC) OGRC, Continental Resources, and a consortium of Bakken producers and service companies. Table 1 presents the current budget for this program. The anticipated contribution from industry is currently estimated at $750,000 per year for a total of $2,250,000, apart from Continental's expected in-kind contribution of $106M over 3 years. To date, Whiting Petroleum Corporation, Marathon Oil Company, Nuverra Environmental Solutions, and SM Energy Company have provided payments for Year 1, totaling $325,000. Invoices have been requested by, and provided to, Petro-Hunt, Hess Corporation, Oasis Petroleum, ConocoPhillips, and Hitachi Data Systems, totaling $450,000 of potential additional funding for Year 1. It is expected that equal payments will be provided by the industry partners in subsequent years. The EERC will also continue to seek broader industry participation.

Expenses to date by funding source are listed in Table 2.

Table 1. Bakken Production Optimization Program – Expected Budget

Sponsors	Y1	Y2	Y3	Total
NDIC Share – Cash*	$3,000,000	$3,000,000	$2,000,000	$8,000,000
Industry Share – Cash (Year 1 payment received)	$325,000	$325,000	$325,000	$975,000
Industry Share – Cash (Year 1 payment pending)	$425,000	$425,000	$425,000	$1,275,000
Continental Share – In-Kind	$40,989,233	$40,989,233	$24,051,534	$106,030,000
Total	**$44,739,233**	**$44,739,233**	**$26,801,534**	**$116,280,000**

*Includes $6.26M subcontract to Continental.

Table 2. Bakken Production Optimization Program – Expenses to Date

	Funding Source		
	NDIC	**Industry**	**Total**
EERC	$225,276	$30,333	$255,609
Continental – Subcontract*	$1,210,000		$1,210,000
Continental – In-Kind**		$87,295,701	$87,295,701
Total	**$1,435,276**	**$87,326,034**	**$88,761,310**

*Invoiced to EERC.
**Reported to EERC.

FUTURE ACTIVITIES

The planned activities for the next quarter include the following:

- Prepare presentation materials summarizing activities associated with remote gas capture technologies; participate in the Flaring Task Force planning meeting in Denver, Colorado, on January 14, 2014; and participate in the NDIC meeting in Bismarck, North Dakota, on January 29, 2014.

- Continue working with vendors to identify opportunities to deploy technology and/or services that match the needs of producers in their efforts to improve gas capture and utilization.

- Continue to consult with partners on NORM waste management strategies via the NORM task force. Provide input as the task force formulates a complementary approach to NDDH's ongoing NORM study.

- Facilitate additional sample analysis of NORM wastes in support of NDDH's ongoing NORM study.

- Attend the NORM North America Conference in Houston in March. Develop resource networks to support industry strategy on NORM waste disposal.

- Future activities related to water management will depend on additional input from industry in terms of needs and interests. A potential activity may be assessing water demands and quality requirements for anticipated well maintenance activities.

- EERC staff will begin visiting with stakeholders regarding the corrosion/scale capabilities outlined previously and solicit their in-depth engagement.

- EERC and Hitachi Data Systems personnel plan to meet with Continental personnel to discuss "big data"-handling approaches and technology and their potential utility for this program.

- MMP investigations using methane–ethane mixtures and Bakken oil will be conducted during the next quarter.

APPENDIX A

85th ANNUAL NORTH DAKOTA WATER & POLLUTION CONTROL CONFERENCE SLIDES

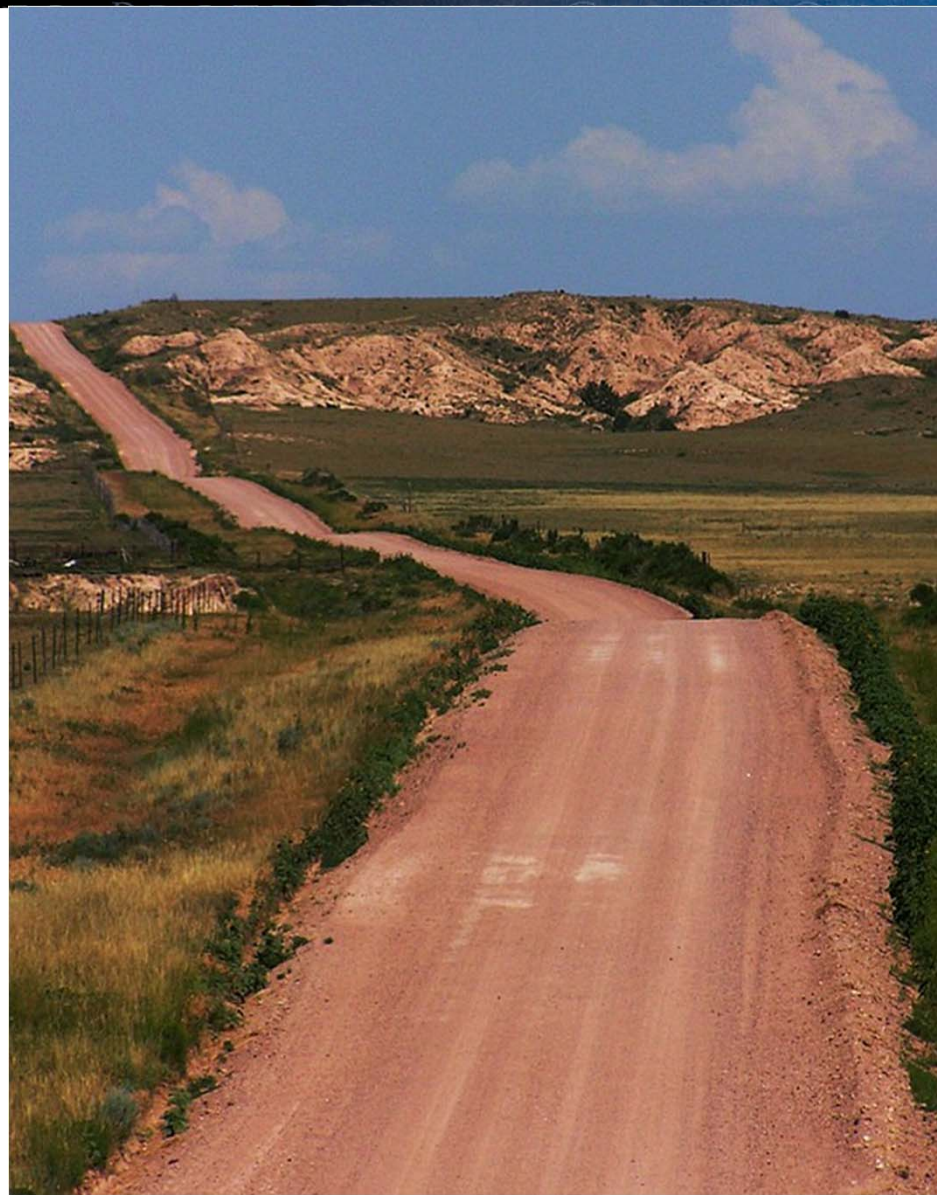
Bakken Research Programs

85th Annual North Dakota Water & Pollution Control Conference
Grand Forks, North Dakota
October 24, 2013

John Harju, Associate Director for Research
Bethany Kurz, Senior Research Manager
Energy & Environmental Research Center (EERC)

Presentation Overview

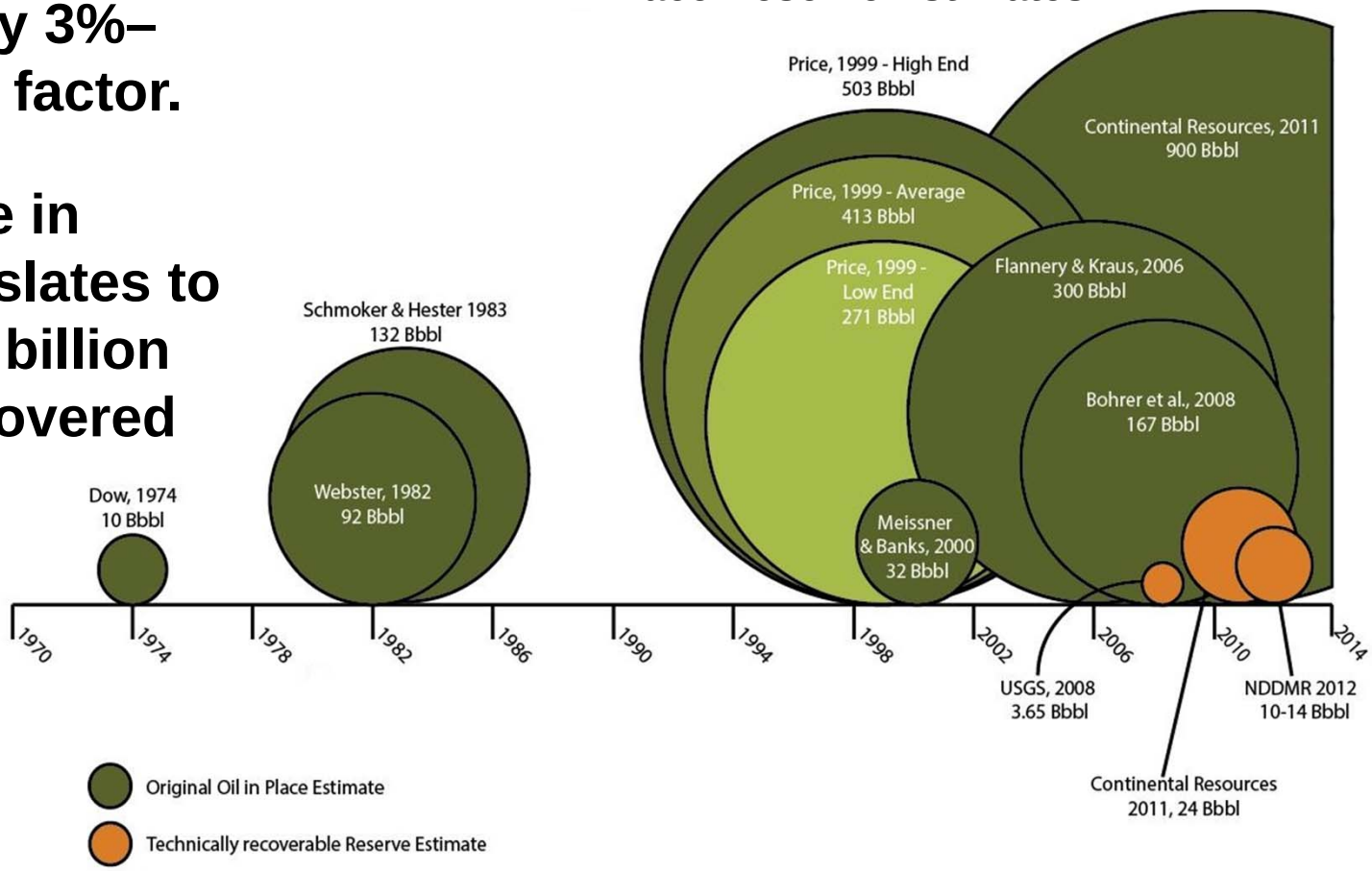
- Ongoing challenges with Bakken development
- Past Bakken research efforts
- Bakken Optimization Program goals



The Bakken Resource

- **World-class resource**
- **Currently, only 3%–10% recovery factor.**
- **A 1% increase in recovery translates to as much as 9 billion barrels of recovered oil (or more).**

Bakken Petroleum System Total Oil in Place Reserve Estimates



Current Downhole Hurdles

- Incomplete understanding of the resource, its potential, and how to best extract the oil with current technology.
  - Optimal well spacing?
  - Communication between formations/benches?
  - Identification of sweet spots.
  - Influence of fracture networks?
  - Optimal completion and stimulation techniques?
  - How to best expand the run life of downhole equipment.

Current Surface Issues

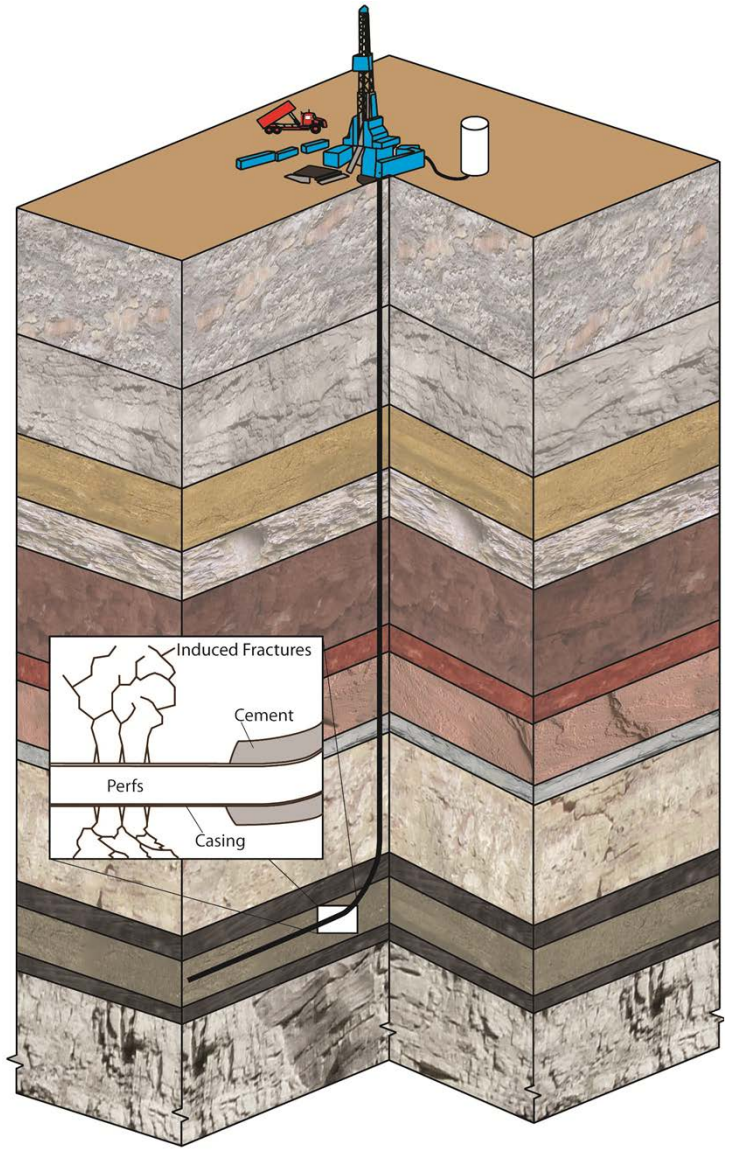
- Flaring and associated gas collection (and utilization).
- Solid waste management.
- Water minimization, recycling, and reuse.
- Associated issues, such as truck traffic, dust, road maintenance, and air emissions.
- Many “issues” are driven by public perception and/or misconception.
- Some of the challenges are a result of regulatory requirements, such as elimination of reserve pits.

Bakken Research Projects/Programs

- Initial Efforts
  - Factors Affecting Bakken Production: Phase 1 and 2
  - Bakken Water Opportunities Assessment: Phase 1 and 2
  - Evaluation of Factors Affecting Proppant Performance
  - Flare Gas Utilization
- Current and Future Programs
  - Bakken CO_2-EOR Feasibility Assessment
  - Bakken CO_2-EOR Phase 2 Feasibility Assessment
  - Bakken Production Optimization Program

Water Needs for Fracturing

- Hydraulic fracturing requires 2 to 5 million gallons of freshwater per well.
- The water is mixed with chemicals (biocides, proppants, polymers) prior to injection.
- A percentage of the frac water returns to the surface (flowback) and is recovered and disposed of (or recycled).
  - Typically contains dissolved solids (salts), suspended solids, residual hydrocarbons, and fracturing chemicals.

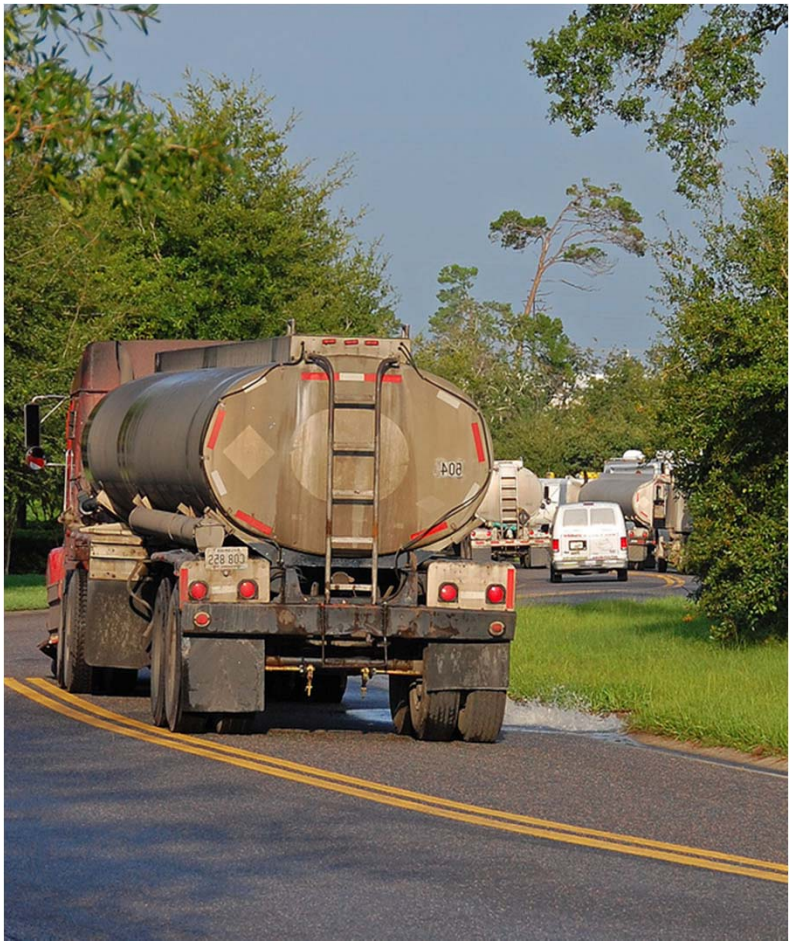


Putting Water Needs in Perspective

- Estimated water demand assuming 2200 wells per year at 4 million gallons per frac: ~ 24.1 MGD
  - 1.8% of total ND fresh water withdrawals
  - Equivalent to about 1.8 inches per year off the surface of Lake Sakakawea.
- Daily pumping volume for a center-pivot irrigator on a ¼ section of land in ND: ~ 1 million gallons
- Typically daily use for a 50,000-person Midwestern city: 10 million gallons.

Bakken Frac Water Costs

- Acquisition costs
  - $0.25–$1.26/bbl of raw water
  - $0.63–$5.00/bbl for transportation
- Disposal costs
  - $0.63–$9.00/bbl for transportation
  - $0.50–$1.75/bbl for disposal via deep well injection
- Total costs
  - $2.01–$17.01/bbl



Bakken Water Opportunities Assessment

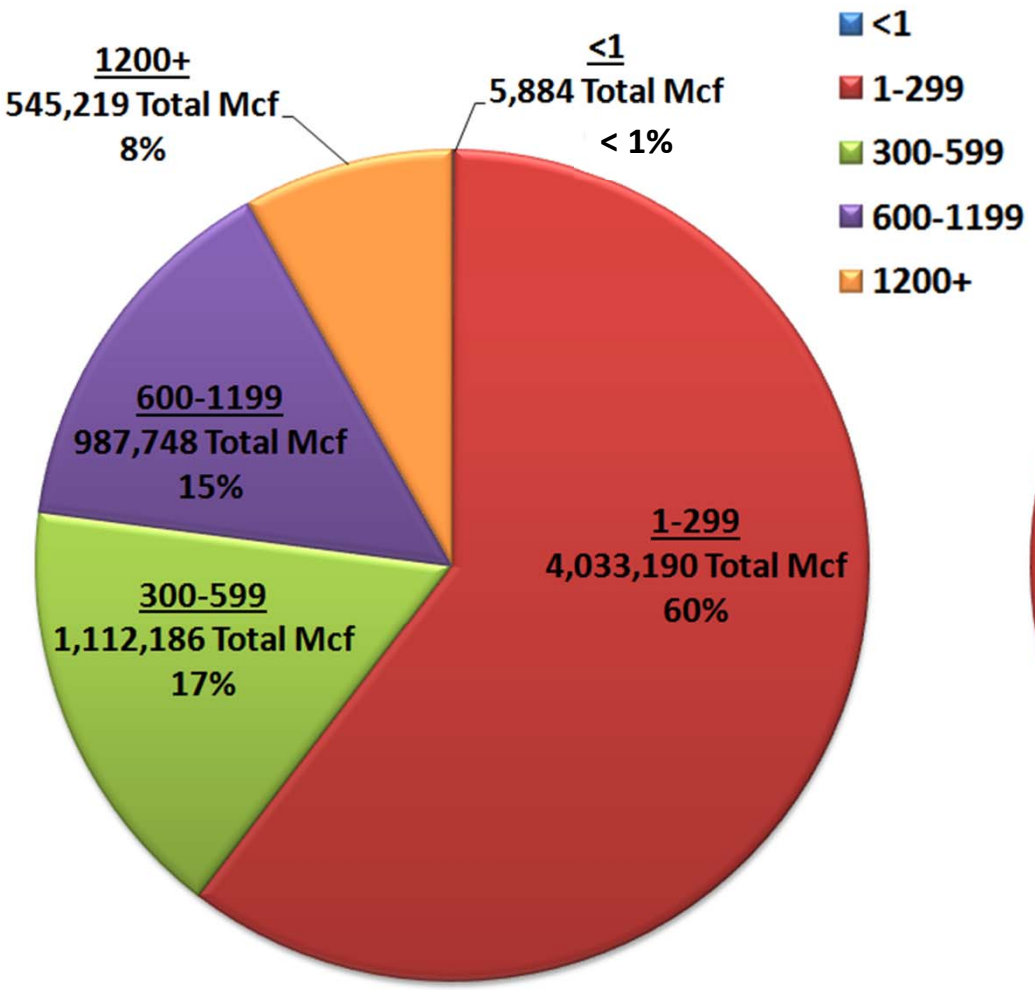
- Phase 1 Goals:
  - To evaluate the feasibility of recycling hydraulic fracturing (frac) flowback waters in the Bakken play.
- Outcomes:
  - Frac flowback quantity and quality data were collected and evaluated from 5 different producers, representing data from a total of 89 wells.
  - Because of low initial flowback water recovery rates (15 to 40% of original volume within 10 days) and extremely high dissolved salt content, we concluded that recycling of Bakken frac flowback water would be challenging.

Bakken Water Opportunities Assessment

- Phase 2 Goals:
  - To assess the technical and economic feasibility of upgrading non-potable groundwater for use in hydraulic fracturing.
- Outcomes:
  - The EERC partnered with Hess Corporation and GE Water and Process Technologies to conduct a pilot project using reverse osmosis (RO) to treat brackish groundwater.
  - The project included an on-site water filling station.
  - This approach was economically competitive with existing water supply sources.

Updated Flare Gas Data – May 2013

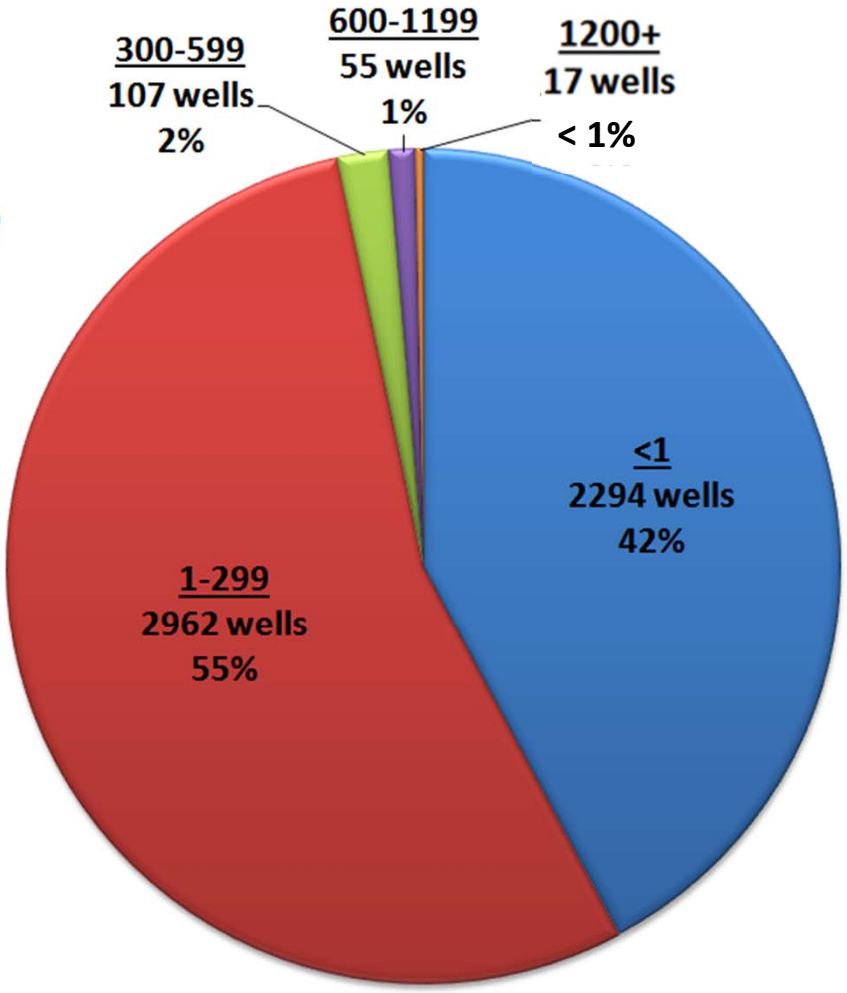
Flaring Allocation by Total Gas Flared



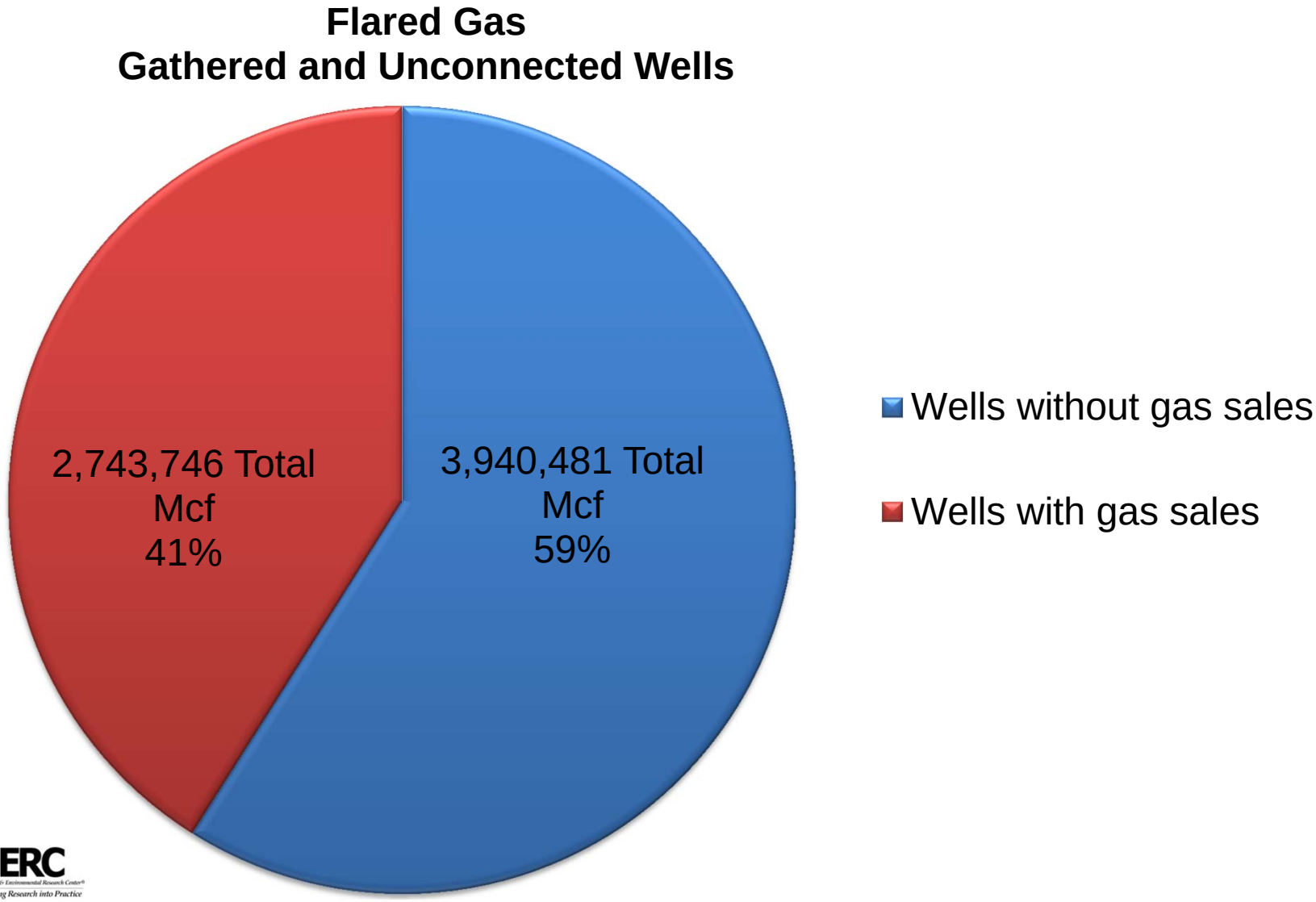
Flaring Rate (Mcf/day)

- <1
- 1-299
- 300-599
- 600-1199
- 1200+

Flaring Allocation by Number of Wells



New Flare Data Analysis – May 2013



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Evaluation of Associated Gas Use

- Bifuel Rig Demonstration – assessment of fuel savings and operational impacts of associated gas–diesel mix
- Associated Gas Alternative Use Study – analysis of gas use options upstream of gas-processing plants
  - Small-scale gas processing
  - CNG/liquefied natural gas (LNG) for vehicles
  - Electric power production
  - Chemical production

Image: http://infinitosrl.net/

EERC Study and Final Project Report
www.undeerc.org/Bakken/researchstudies.aspx

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A Use for Flared Natural Gas

- Power production for drilling rigs is a near-term opportunity.
- Diesel engines properly outfitted with bifuel systems can utilize a mixture of diesel and natural gas.
- Significant fuel savings can be achieved:
  - 30%–60% reduced fuel costs
  - Reduced fuel delivery and associated traffic, engine emissions, and fugitive dust

Image: www.drillingcontractor.org

Summary of Results

- Diesel fuel consumption reduced by 18,000 gallons for two wells over a period of 47 days.
- Fuel-related net cost savings of nearly $60,000.
- Reduced delivery truck traffic.
- Reduced NO_x emissions and increased CO and HC emissions compared to diesel-only operation. Mitigation achievable with exhaust gas treatment.
- Seamless engine operation using the GTI Bi-Fuel® system.
- Currently ECO-AFS has Bi-Fuel® on 21 rigs and 200 generators in North Dakota.

Impact of Widespread Use

- Nearly 200 drilling rigs in operation at any given time
- 1,800,000 Mcf of wellhead gas used per year
- 18,000,000 gallons of diesel fuel saved per year
- $72,000,000 diesel fuel cost saved per year
- 3600 fuel deliveries avoided per year

Bakken Optimization Program Goals

To facilitate ongoing efforts by industry and the state to optimize Bakken/Three Forks production:

- Advanced reservoir characterization and more accurate resource estimates.
- Improved drilling/stimulation/completion/production techniques and sequences.
- Optimization of wellsite surface operations and reduced surface impacts.

Image: http://blogs/calgaryherald.com

Bakken Optimization Program Partners

North Dakota oil & gas research program

Continental Resources

SM Energy

EERC Energy & Environmental Research Center® Putting Research into Practice

Marathon Oil

ConocoPhillips

Whiting

Oasis Petroleum

Petro-Hunt, L.L.C.

Nuverra Environmental Solutions™

Hess

Benefits of Optimization

Production Optimization

- Increases revenue to industry and the state (and associated benefits to residents).
- Facilitates continued investment of the oil and gas industry into the oil and gas resources of the region.
- Assures conservation by optimizing the efficient and effective recovery of the oil and gas resource.

Image: Popular Mechanics

Benefits of Optimization

Wellsite Operation Optimization

- Reduce costs and improve efficiency.
- Reduce development and operational impacts to surrounding landowners and environment.
- Reduce demands on surrounding infrastructure and water sources.

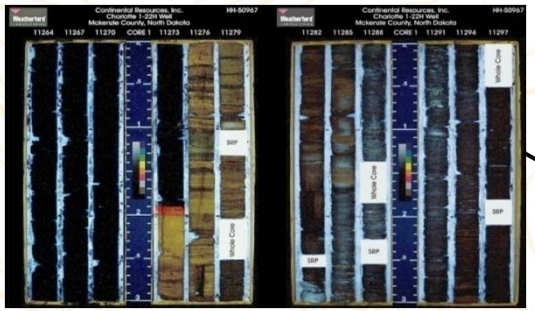
Production Optimization:
Hawkinson Project

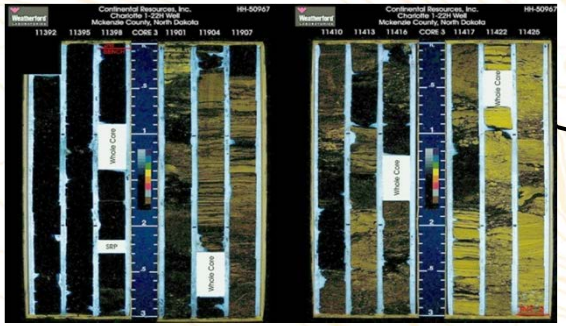
INDEPENDENT MEANS

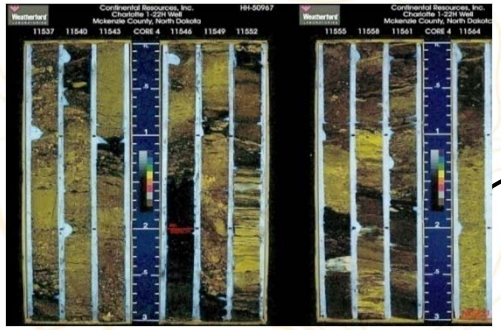
Continental RESOURCES

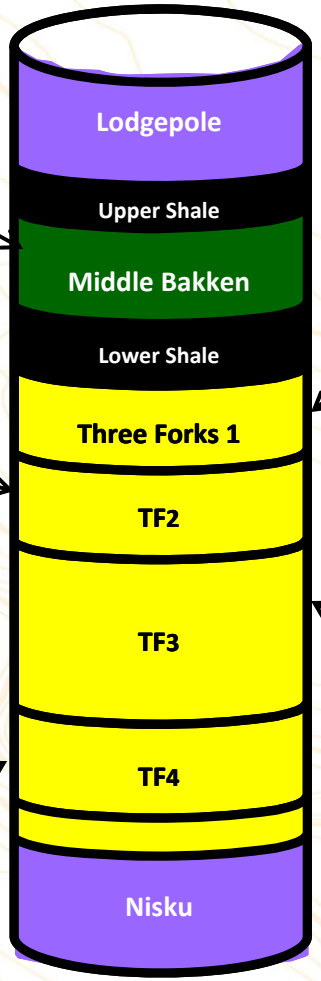
Bakken Petroleum System Redefined

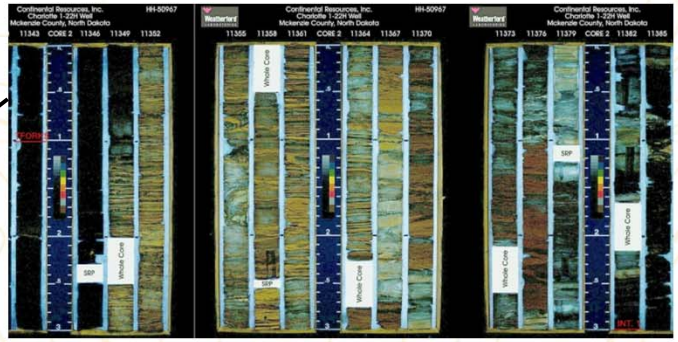
Charlotte 1-22H core photos
(UV light)
308’ with 154’ of oil
fluorescence

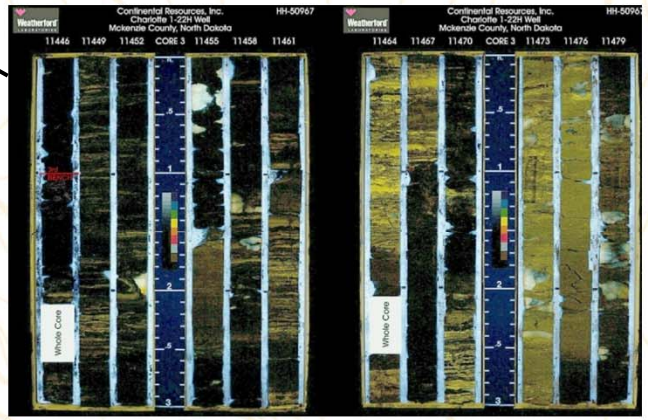






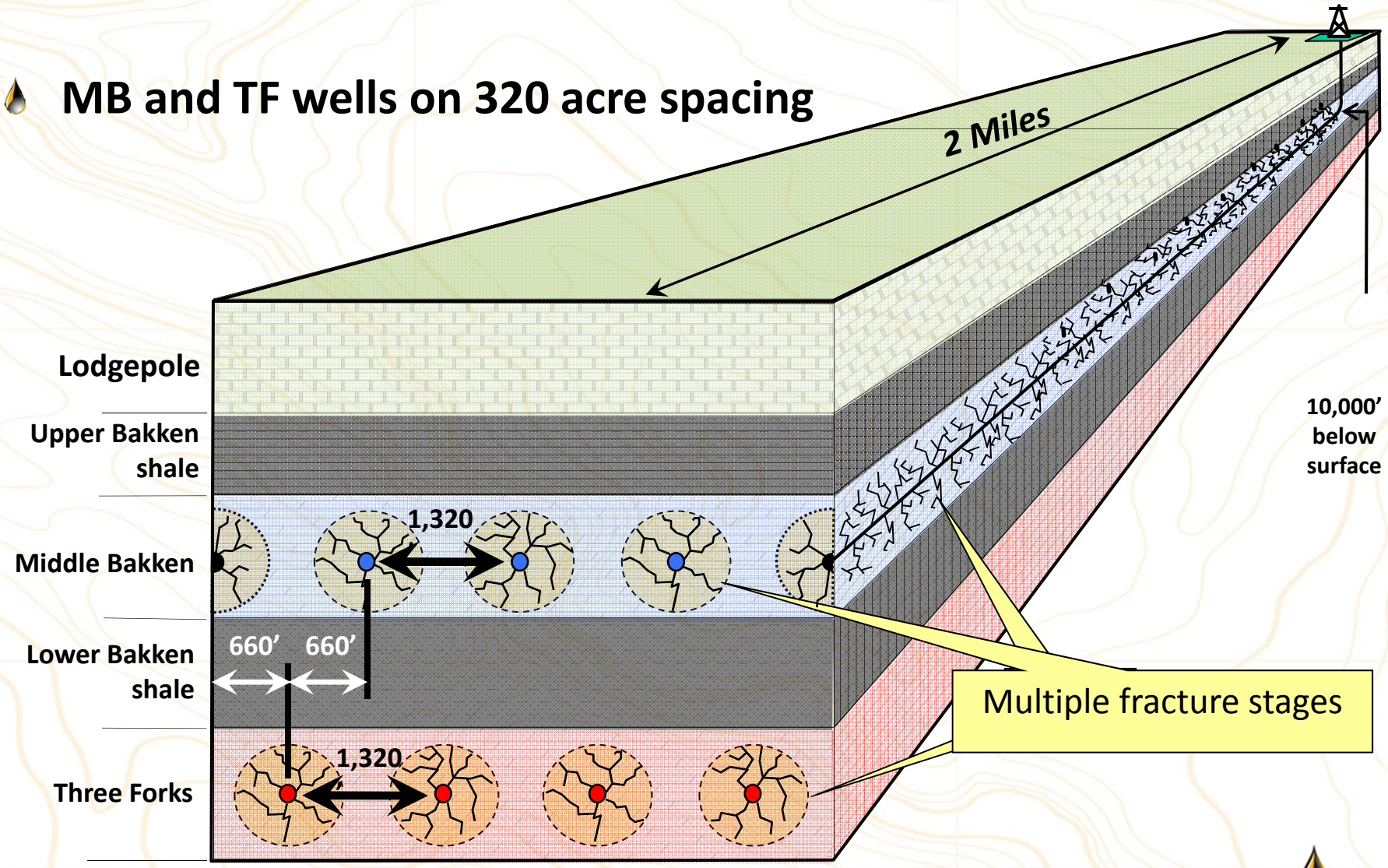




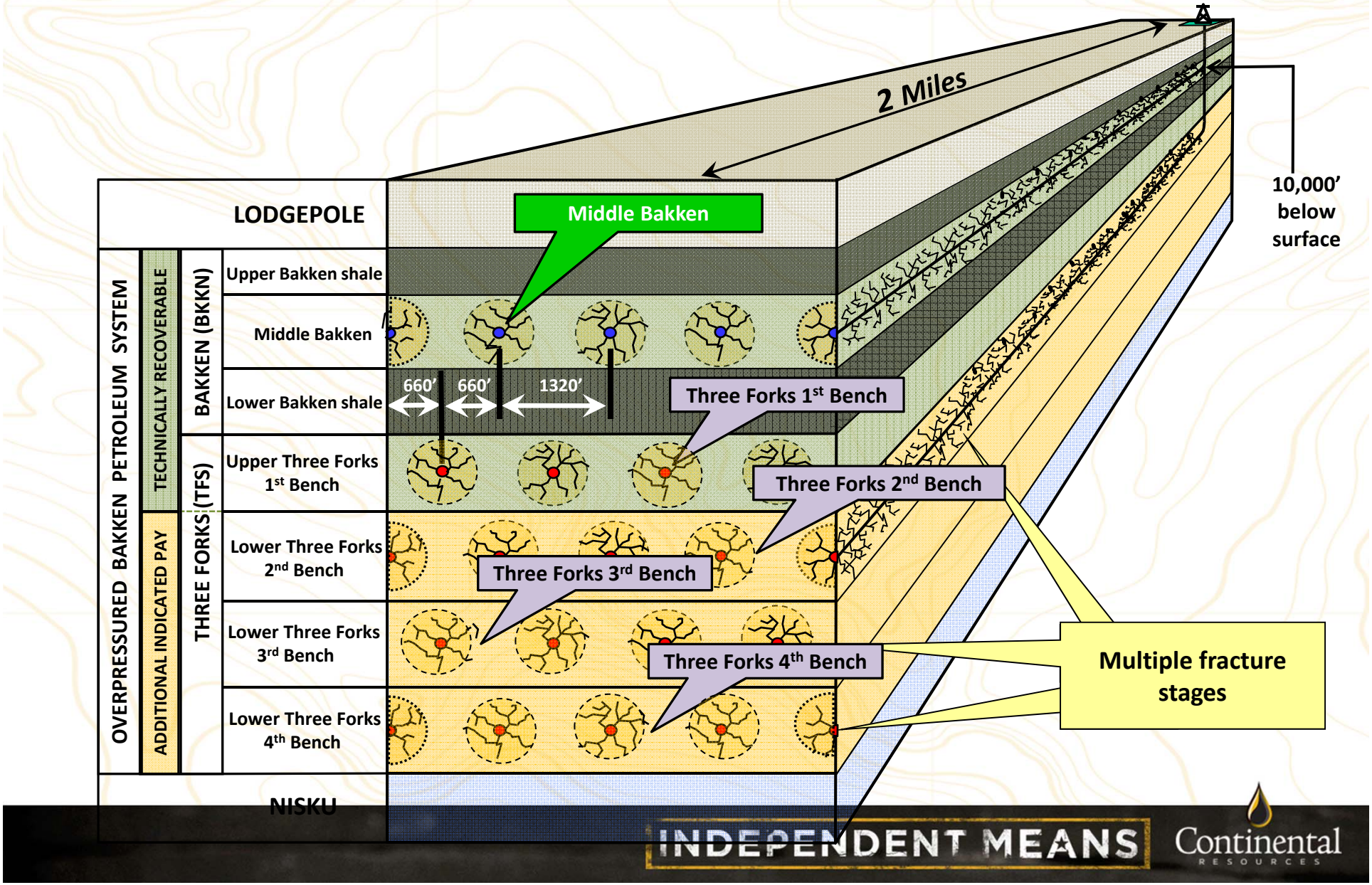


Past: Dual Reservoir Development

- MB and TF wells on 320 acre spacing



Current Development: Bakken & Three Forks



INDEPENDENT MEANS

Continental RESOURCES

Production Optimization Goals

- Define reservoir drainage of the MBK, TF1, TF2 & TF3
- Confirm whether these formations are distinct and separate from each other
- Determine appropriate well spacing required for most efficient reservoir drainage
- Increase spacing unit ultimate recovery
- Predict areas of future reservoir sweetspots

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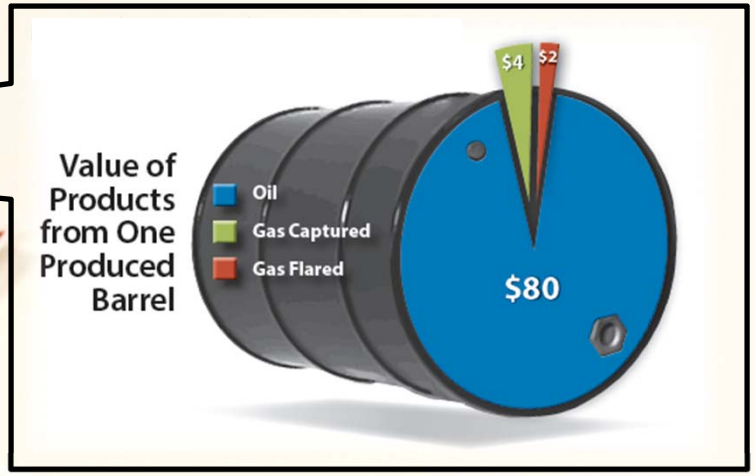
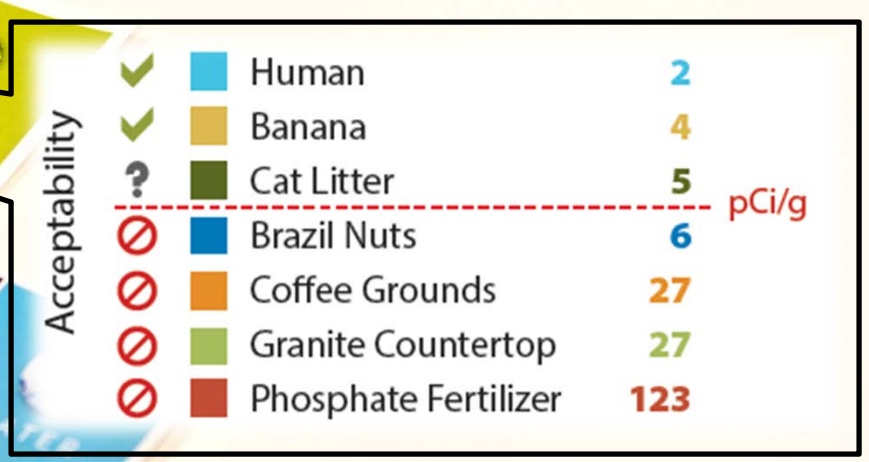
Optimization of Wellsite Operations

Areas to Be Addressed

- Flare gas collection and utilization.
- Improved waste handling and options for beneficial reuse.
- Options for water recycling, treatment, and reuse.
- Other surface and downhole operational issues (corrosion, scaling, casing integrity).

Public Education





We Need a Paradigm Shift

- Issues related to oil and gas development should not be the sole responsibility of industry.
- EVERYONE benefits from (relatively) inexpensive, abundant supplies of oil and gas.
- Optimizing production of this resource benefits everyone – let's tackle it collectively.

For More Information…

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