Water and Unconventional Natural Gas Production Regulatory / Policy Consideration and Initiatives

Pittsburgh, PA – September 29, 2010

Louisiana Haynesville Shale Model: Finding Success through Development of Flexible Institutions and Balanced Adaptive Water/Energy Management

Red River Watershed Management Institute - LSU Shreveport

Gary Hanson, Director

Amanda Lewis, Assistant to Director
Foster awareness, appreciation and protection of the unique environment of the Red River Basin by facilitation of research, educational and recreational opportunities.

Mission Statement

Foster awareness, appreciation and protection of the unique environment of the Red River Basin by facilitation of research, educational and recreational opportunities.

Red River Education & Research Park
Evolving Community-based Nature Education & Research Park Model (Red River Education & Research Park)

The Institute and the Park have been developed as flexible institutions, from the start, solving real-world problems by constantly adapting.

An adaptive model - Based on "Sense of Place" institution building
An Environmental Partnership between the City of Shreveport and LSU Shreveport
Local Elementary School Children Visiting SWAMP

Surface Water Analysis & Monitoring Platform
LSUS 001 Monitoring Well Project - Wilcox/Alluvial Aquifer

Magnetic Resonance Imaging Log (MRIL)

Research

Halliburton Logging Well

Red River Alluvial Aquifer

Wilcox Aquifer

LSUS Red River Watershed Management Institute
Using suite of borehole logs to evaluate Red River Alluvial Aquifer & Carrizo-Wilcox Aquifer

LSUS students using Geoprobe to develop monitoring well in Red River Alluvial Aquifer

“Not scared of dirt, willing to work”
Red River Education and Research Park
A Public Park

- Bat Habitat
- Field Station
- Monitoring Well
- SWAMP
- LTEMP
- Red River Education and Research Park
- A Public Park

- Long-term Surface Water Monitoring Equipment
- Ground Water Monitoring Well (Red River Alluvial)
- Ground Water Monitoring Well (Carrizo-Wilcox, Caddo Parish Coop. Project)
- Ground Water Monitoring Well (Carrizo-Wilcox)
- Floating Dock
- Surface Water Monitoring Site
- Acoustic Doppler Site
- Artificial Bat Habitat
- Field Station Building
- Test Plots (Agricultural and Natural Field)
- Research Barge
- Nutrient Analyzer

LSU in Shreveport
Red River Watershed Management Institute
LSUS Anderson Watershed Research Field Station

Funded by USEPA Region 6 and Anderson Oil and Gas
Water Resources Committee of Northwest Louisiana Watershed Based - Volunteer Committee

A Self-organizing Institution

WRCNL evolved from a 2003 committee formed by the Caddo Parish President, a concerned citizen & Director of RRWMI at LSU Shreveport
The Water Resources Committee of Northwest Louisiana
Established June, 2004
Mission Statement
The Mission of the Water Resources Committee of Northwest Louisiana is to ensure a dependable, clean and affordable source of water, now and in the future, for our people, our economy and our environment through the development of interregional water management strategies. The Committee will work toward the preservation, protection, and development of the water resources of the Red River Basin in northwestern Louisiana and its adjoining areas for the maximum benefit and use of the citizens and industries in its service area (Caddo, Bossier, Desoto and Webster Parishes, and City of Shreveport)

WRCNL evolved from a 2003 committee formed by the Caddo Parish President, a concerned citizen & Director of RRWMI at LSU Shreveport
Long Term Consequences of Excessive Groundwater Withdrawal
Potentiometric Surface of Carrizo-Wilcox Aquifer

Carrizo-Wilcox Aquifer level is declining

Slow recharge rate!
To most folks... where THEIR water comes from may be a mystery...

**HOW WE GET WATER IN OUR HOMES**

I DON'T HAVE ANY INFORMATION ON THIS BIT

But...
Water is a cultural issue - More than just a commodity

Baptism ceremony in Caddo Lake

This remarkable photograph captured a highly attended baptism ceremony conducted by the Mooringsport Baptist Church at the foot of the traffic bridge in Mooringsport in 1915. Automobiles and pedestrians are strung along the traffic bridge, and other observers lined up along the shoreline and out over the water in boats. Within the arc defined by the boats and the people onshore, the preacher can just be seen performing the baptismal rite. (Courtesy Mooringsport Mini Museum.)
Water is a cultural issue - More than just a commodity

Baptism ceremony in Caddo Lake

Caddo Lake is split in half by the Texas/Louisiana border

The only natural lake in Texas

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Water is a cultural issue - More than just a commodity

This remembrance by the Mooringsport Mini Museum states: "This remembrance at Mooringsport Mini Museum depicts a shore scene and the people onshore, the preacher can just be seen performing the baptismal rite."
Water and Culture - More than just a commodity
Parishes Overlying Carrizo-Wilcox Aquifer

LSUS Red River Watershed Management Institute
Generalized Geologic Cross-section
Northwest Louisiana

After Thorkildsen and Price, 1991

LSUS Red River Watershed Management Institute
Phase I wells were collecting data prior to the Haynesville Boom

Caddo Parish/ LSUS Carrizo-Wilcox Monitoring Well Project

Monitoring Well Sites

1. Walter Jacobs Park
2. Hannah’s Park
3. Mayo Road
4. Keithville
5. Springridge

Phase II Wells drilled in 2010

Red River Watershed Management Institute
LSU Shreveport
LSUS/Caddo Parish Carrizo-Wilcox Monitoring Well Project

Walter B. Jacobs Memorial Park. LSUS students were involved in all phases of mapping, planning, drilling & development of the monitoring wells in the joint project.

Drilling of the project’s first groundwater monitoring well at Walter B. Jacobs Memorial Park. LSUS students observe drilling operations.
Haynesville Shale Gas Discovered in Northwest Louisiana - 2008

Haynesville Top Drive Rig Drilling On Left & Adjacent Well Undergoing Hydraulic Fracture Stimulation (right)

Frac job underway

Gary Hanson, 2009
Louisiana Haynesville Shale Activity Map - 2008

293 wells

LADNR, 2008
Louisiana Haynesville Shale Activity Map - 2010

1,542 Total Haynesville Shale Wells

1542 wells
Generalized structure contours on top of Cotton Valley Group sandstone across northeastern Texas and northern Louisiana, modified from Finley (1984).
Water Sources for Haynesville Play

- **Groundwater**
  - **Carrizo-Wilcox Aquifer**
    - Initially the main source for fracking

At the start of Haynesville boom, many operators did not fully appreciate Louisiana’s groundwater regulations.
Professional waterworks administrators became convinced that the withdrawal of excessive amounts of groundwater by gas operators was depleting the aquifer.
Caddo Parish/LSUS GW Monitoring

Keithville Compactor

Typical Carrizo-Wilcox seasonally influenced water level curve

Hanson et al, 2010
Water level appeared to be dropping rapidly in this area of heavy drilling & hydraulic fracturing

Hanson et al, 2010
Alternative Water Sources – South Caddo, Desoto Surface Water

Smithport Lake

Red River

Toledo Bend Reservoir

Sabine River

Who owns the surface water in Louisiana?
Alternative Water Sources - Red River Alluvial Aquifer

Office of Conservation recommended that operators use the Red River Alluvial Aquifer for fracking wells.

Non-Potable - Yields up to 1600 gallons/minute
The Times (Shreveport) - This article is a good example of how the press can inform and educate the public.
Alternate Water Sources for Frac Water - Ponds

Get Rich Quick?—Don’t sale the farm, just sell the pond water...

Landowners hope ponds suck in drilling dollars

By Vickie Welborn
welborn@gannett.com

MANSFIELD -- It’s not often that a dirt contractor says he’s glad it’s raining. But Dennis Bell was among the few who didn’t mind last week’s rain.

Because every drop that might have kept him from a job was serving another purpose: filling up the many ponds that Bell has constructed for himself and others. One at his home on state Highway 522 east of Mansfield was practically dry before the deluge. After interests.

The Police Jury for months has been attempting to get a clear opinion from the state attorney general’s office on water ownership rights on the water lakes.

Among that, Assistant District Attorney Gary Evans last month issued his own opinion, stating that the lake water was owned by the state of Louisiana. But since a mechanism is not in place to handle water sales, Evans suggested the Police Jury, as a political solution, sell the water. Industry built ponds through a competitive process.

The Times Oct. 19, 2009
Water Wars - Ponds started to dry up

“I’m looking for something in a small pond.”
Moving the gas industry from groundwater to surface water

First attempts to acquire permission to set up withdrawal sites on the Red River were met with long delays and what appeared to be inaction by the US Corps of Engineers.

Eventually, the Red River Watershed Management Institute joined with the Red River Waterway Commission and organized a meeting between the Corps and some of the natural gas operators at LSUS.
Utilization of Red River Water As a Source For Natural Gas Well Drilling and Stimulation

A Working Meeting – April 2, 2009

Participants:

US Army Corps of Engineers Vicksburg
Red River Waterway Commission
Red River Watershed Management Institute
Water Resources Committee of Northwest Louisiana
Caddo Levee District
Natural Gas Industry Representatives: Camterra Resources, Chesapeake Energy, Questar Exploration & Production, and Petrohawk Energy
Louisiana Oil and Gas Association
Wyatt Overton & Associates
Red River Valley Authority
Water Energy Working Group – Meeting at LSU Shreveport
WG became more flexible & adapted to issues before or as they arose

Co-chairs: Directors of Red River Watershed Management Institute & Red River Waterway Commission
WG became more flexible & adapted to issues before or as they arose

Participants:

US Army Corps of Engineers Vicksburg (USACE)
Red River Waterway Commission, LAF&WS, LADEQ
Red River Watershed Management Institute (LSUS)
Red River Valley Assoc., Sabine River Authority, Caddo
Levee District, Bossier Levee District, La DOTD, U.S. Fish
& Wildlife Service, Chesapeake, Questar, EnCana,
Petrohawk, Camterra, J&W, Exco, Shell, El Paso,
Louisiana Oil and Gas Association, Red River Pump,
Impact Energy Services, Water Resources Committee of
Northwest Louisiana, International Paper Company

Early on & on a voluntary basis, most Haynesville operators reduced
their use of groundwater

Co-chairs: Directors of Red River Watershed Management
Institute & Red River Waterway Commission
From Groundwater to Surface Water
Learning to Deal with the Haynesville Boom

Self-Organizing

- The Working Group was initially formed as an ad hoc committee to assist operators gain access to the Red River as a frac water source in lieu of stressed groundwater aquifer.
- Like other regulatory entities experiencing the incredibly rapid development of the Haynesville, USACE was suddenly confronted with unique water related issues (sent 8 managers!).
- In order to gain access to river sites for water withdrawal, USACE determined that a Section 10 permit was required (does not give permission to take water).
- Although Louisiana had previously enacted groundwater legislation, at the time there was no surface water legislation.
A second meeting was called about a month later to provide the Corps with estimated future withdrawal rates/volumes and to finalize a protocol for permit submission. Just prior to the meeting, Chesapeake was issued the first permit. After this meeting 20 more permits were issued to several other operators. All participants were working well together!
The WG agreed to invite the press to the second meeting. Excellent, informative news coverage for the public followed.
From Groundwater to Surface Water
Water Energy Working Group

Third Meeting - Resilience

- Operators were granted permits, and since Louisiana is a riparian state, they paid the landowners for access across their property.
- The third meeting was called because, operators were told permits were being held up by US Fish and Wildlife Service.
- The USF&WS was contacted and a high-level manager attended our third meeting. He informed the operators that they had to take measures to protect three threatened or endangered species in or along the Red River.
- In response, operators developed survey protocols for Earth Fruit, the Interior Least Tern and developed slotted water intake manifolds to protect Pallid Sturgeon and other small fish.
Alternative surface water frac sources
EXCO is building an 8 mile pipeline in order to use treated wastewater from International Paper Co. at Mansfield, La.

12 million gallons/day
From Groundwater to Surface Water
Water Energy Working Group

More Challenges – Adapting to Change

- When one of the Haynesville operators attempted to draw river water in Shreveport, a state Representative sent a letter to the state’s Attorney General asking for a ruling on who owned surface water in Louisiana.

- Surface water “opinions” were rendered by Attorney General stating that the state owns all “naturally running water.”

- The AG opinions were used as the basis for enacting surface water use legislation. Act 955 calls for the establishment of cooperative endeavor agreements (CEA) in order to withdraw water from streams or lakes fed by streams.

- Act 955 is a flexible bill. It is voluntary but since it follows the AG Opinions, operators who apply & receive a CEA will be in compliance with state law and not subject to litigation.
This gives DNR a tool for tracking water use

September 15, 2009

TO: All Concerned

FROM: James H. Welsh
Commissioner of Conservation

SUBJECT: Reporting Requirements for Water Use in E&P Operations

To promote effective groundwater resource management and to aid in the development of policies and regulations to protect these resources, it is the policy of this Office to require the reporting of information related to water use in drilling, completion, stimulation and workover operations.

Specifically, the water source and associated volume must be reported on page two (2) of the ‘Well History and Work Resume Report’ (Form WH-1) which must be filed within twenty days after completion or recompletion operations. The water sources must be identified by either the water well number or water body name, as appropriate. Separate water volumes for rig supply use and stimulation operation use must be provided. A completed example of page two (2) of the ‘Well History and Work Resume Report’ (Form WH-1) is attached.

At this time, the policy shall only apply to wells for which a work permit is issued to conduct hydraulic fracturing stimulation operations.
This gives DNR a tool for tracking water use during this timeframe, DNR was becoming more flexible & proactive. The Secretary held numerous, lengthy public meetings throughout the State. After completing an oil or gas well, all operators have to fill out an Office of Conservation Well History and Work Resume Report Form (WH-1). Now operators also have show their water use on Page 3 of the WH-1.

<table>
<thead>
<tr>
<th>Groundwater supply well</th>
<th>Total Groundwater Used</th>
<th>Total Surface Water Used</th>
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<tbody>
<tr>
<td>GWR 12-0015</td>
<td>RED RIVER</td>
<td>1,100,000</td>
</tr>
</tbody>
</table>
Reducing the use of groundwater:
How is the voluntary approach working?

Results?

Source: EnCana, 2010
Haynesville WH-1 Water Volumes by Company

Since Oct. 2009

Source: Louisiana Department of Natural Resources, 2010

Surface water

Water Well Usage Data
10/1/2009 to 8/20/2010

Millions of Gallons

Rig Supply Ground Water
Rig Supply Surface Water
Other Ground Water
Other Surface Water
Frac Supply Ground Water
Frac Supply Surface Water

Since Oct. 2009
Total Water Usage, 10/1/2009 to 8/20/2010

- Surface Water: 1,762,325,986 (79%)
- Frac Supply Surface Water: 1,745,034,834 (8%)
- Rig Supply Ground Water: 263,026,889 (12%)
- Other Ground Water: 254,304,035 (12%)
- Other Surface Water: 5,944,375 (0%)
- Other Ground Water: 4,033,153 (0%)

Source: Louisiana Department of Natural Resources, 2010
The voluntary development of internal water/environmental policies by natural gas operators

Petrohawk runs a model spill prevention program.

Some unique components include:

- Rig footprint is carpeted with a lipped cement liner – this preventative measure keeps anything on rig site from coming in contact with soil
- Tanks or anything holding liquids are surrounded by impermeable traps to contain potential leaks
- Oil based cuttings are directly trapped in tanks and do not come into contact with soil
- Plastic liners are placed under all completion operations
- Our contractors are held to a zero tolerance policy!

0% use of groundwater for fracing
Our community and state has experienced the critical need to understand & apply adaptive approaches, which in turn, have led to the tacit knowledge that we have learned. Go back to your community, roll up your sleeves and start working across the table with those who hold differing perspectives about our natural resources. For it is only by honestly confronting these deep, difficult problems that face our society that we hope to resolve them.

“Tell me and I forget. Teach me and I remember. Involve me and I learn.”

Benjamin Franklin

Gary Hanson, 2004
Acknowledgements:

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LSU Shreveport & LSU System
Halliburton
Anderson Oil & Gas
Louisiana Dept. of Natural Resources
The Parishes of Caddo, DeSoto, Bossier & Webster, Sabine River Authority & Red River Waterway Commission
Members of the Water Energy Working Group