The Environmentally Friendly Drilling Systems Program

Integrating advanced technologies into systems that significantly reduce the impact of petroleum drilling and production.

Awarded october 5, 2009

INTERSTATE Oil & Gas COMPACT COMMISSION

CHAIRMAN'S STEWARDSHIP AWARDS

EFD

Goal of EFD: Major Reduction in E&P Footprint

- **Low Footprint Rig Operations**
- **Produced and Frac Flow back Brine Management**
- **Lower Air Emissions**
- **Lessened Surface Footprint**
- **Public Stakeholder Involvement (Society Issues)**

Thank you Sponsors!

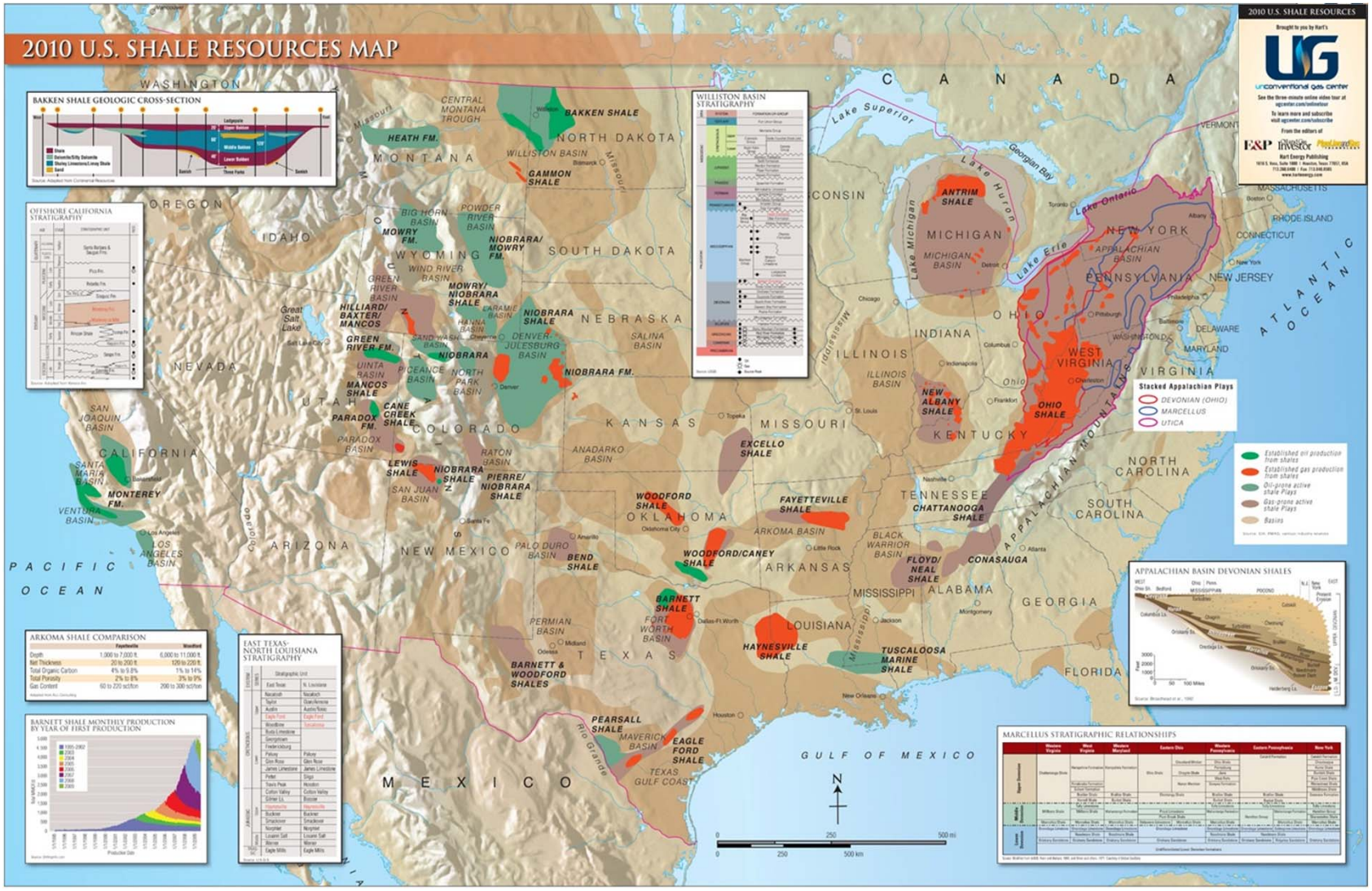
WyoComposites, LLC

Unconventional Petroleum Energy Resources are Plentiful

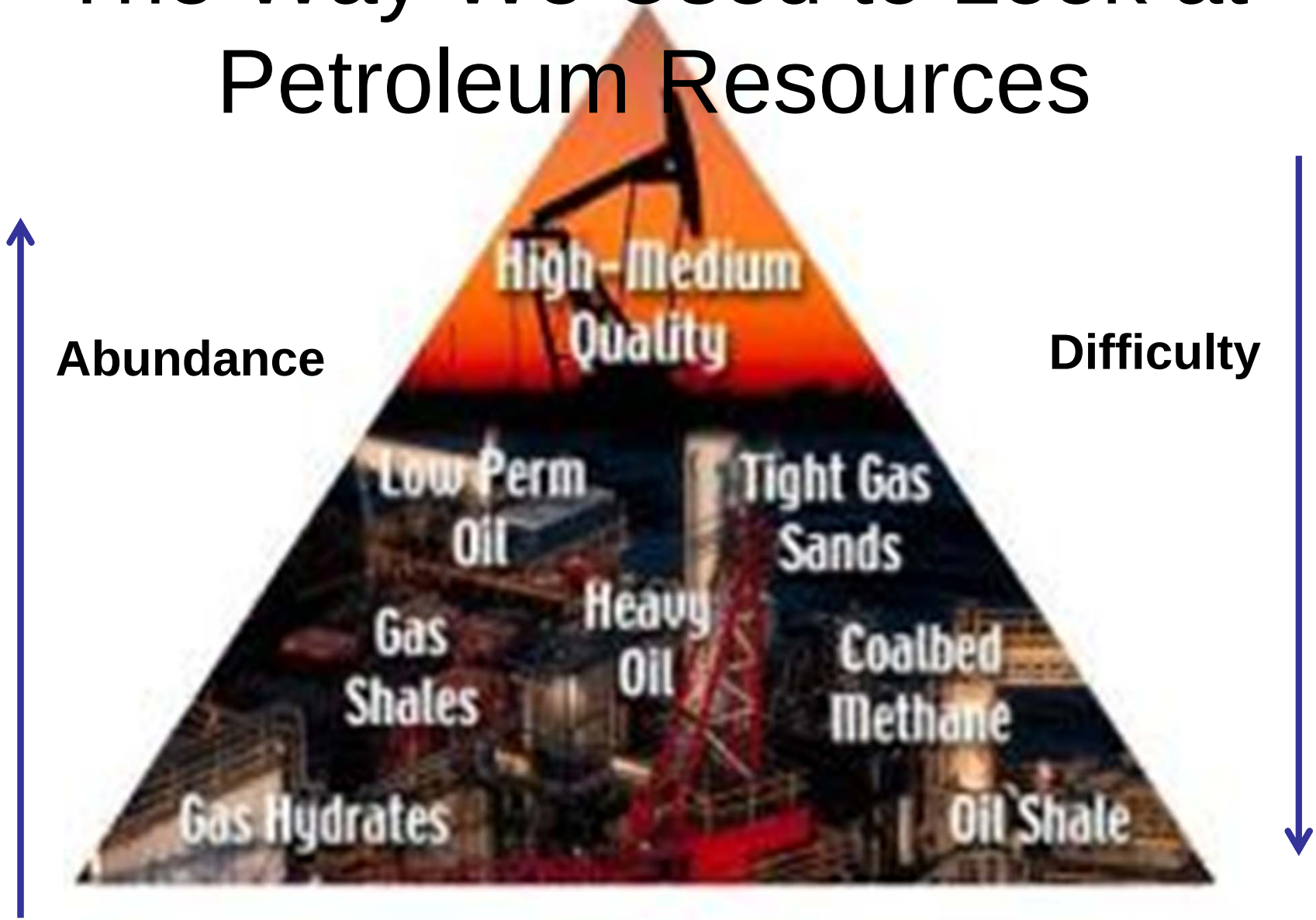
Technology is available, but it will be the environmental issues and society's acceptance that slow the development of shale gas resources in South Texas

Today's Expanding Natural Gas Resource

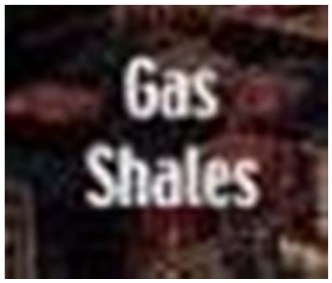
(Hart Publications)



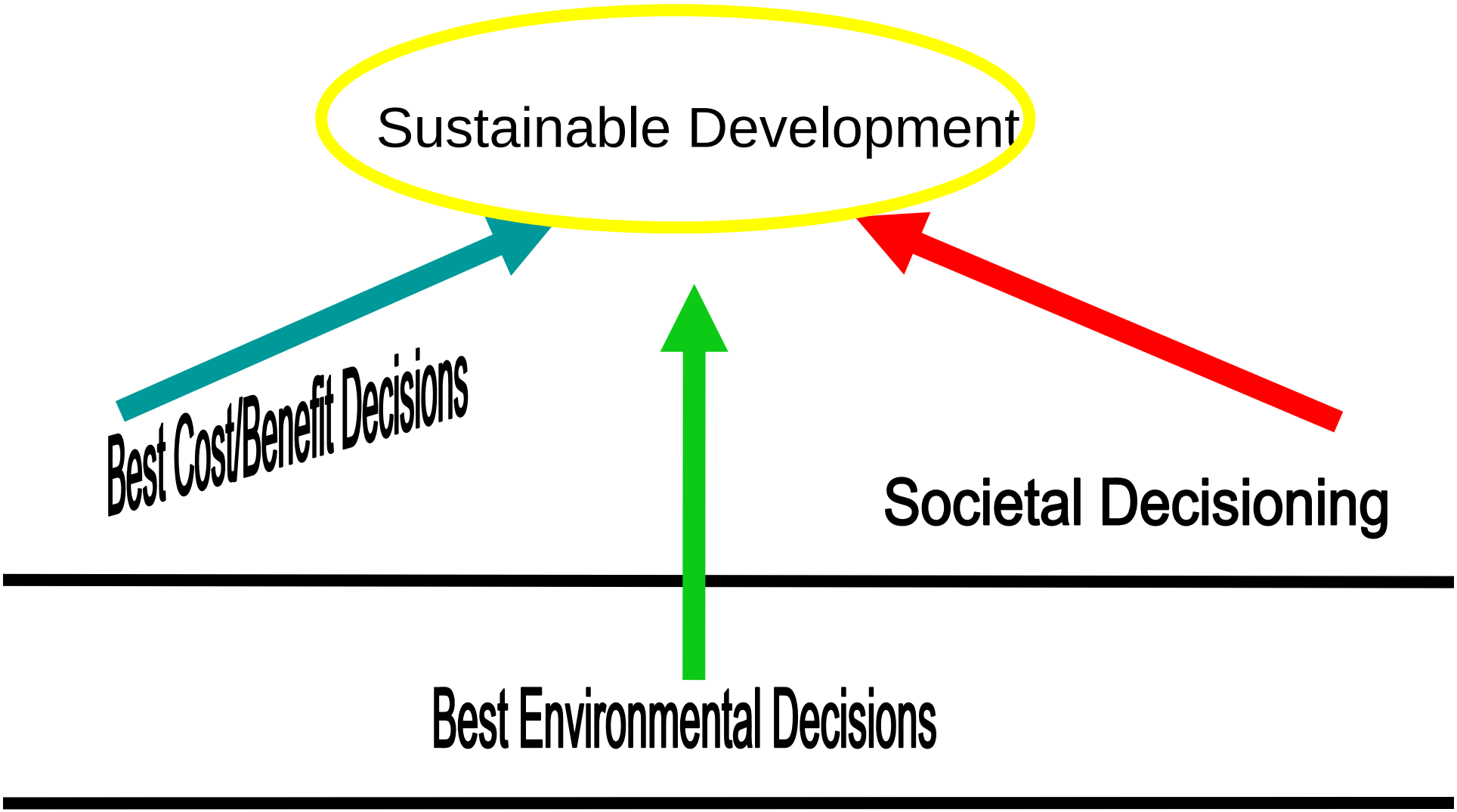
The Way We Used to Look at Petroleum Resources



A New Vision of Fossil Energy



Exploration and Production in Environmentally Sensitive Areas



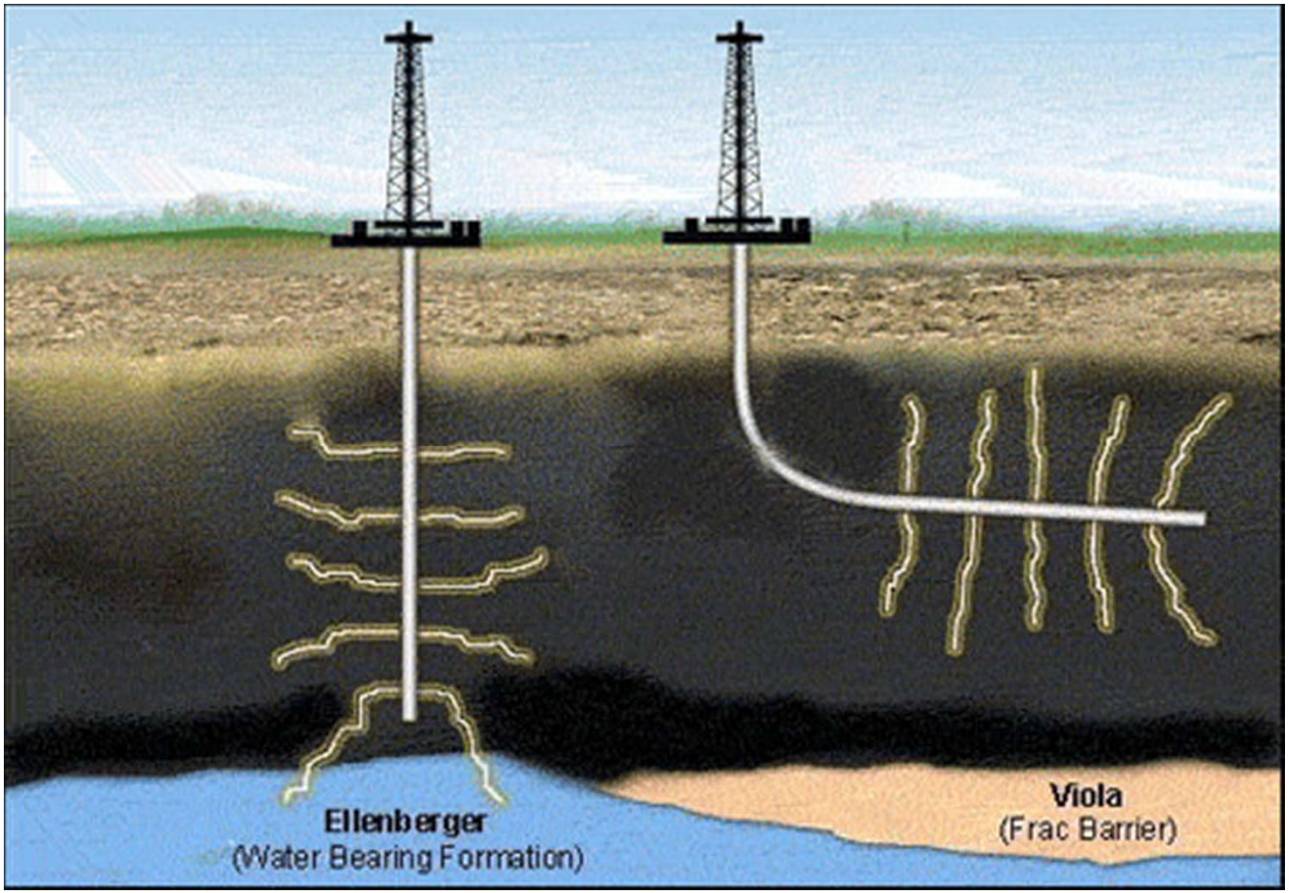
Description of Technology

One Gas Shale Well Equivalent to City of Cotulla, TX

Water Usage	Well Operations	City Operations(1)	Comments
Water Usage	5 to 10 million gal	18 million gal (3 mo.)	A 3 to 10 year supply for “typical” rural well
Power Use	7,500 HP	6 MW (8,000 Hp)	Avg. SCR rig
Solid Waste	200,000 lbs. (7,000 ft well, basement, road & pad +incidentals)	2,000,000 lbs (3 months)	3 mo. Ops.
Unit Budget	~$ 3.2 MM	~$1.7 MM	3 mo. Ops.

(1) Based on comparison to Andrews TX city budget (pop.9,600) 2008 FY
(2) TCEQ Statistical Estimates for Individual water well, rural property

Schematic of Massive Hydraulic Fracturing Stimulation of Shales



http://www.freewebs.com/mana76016/gaswells1.jpg

1.4 Platform/Rig Site Options

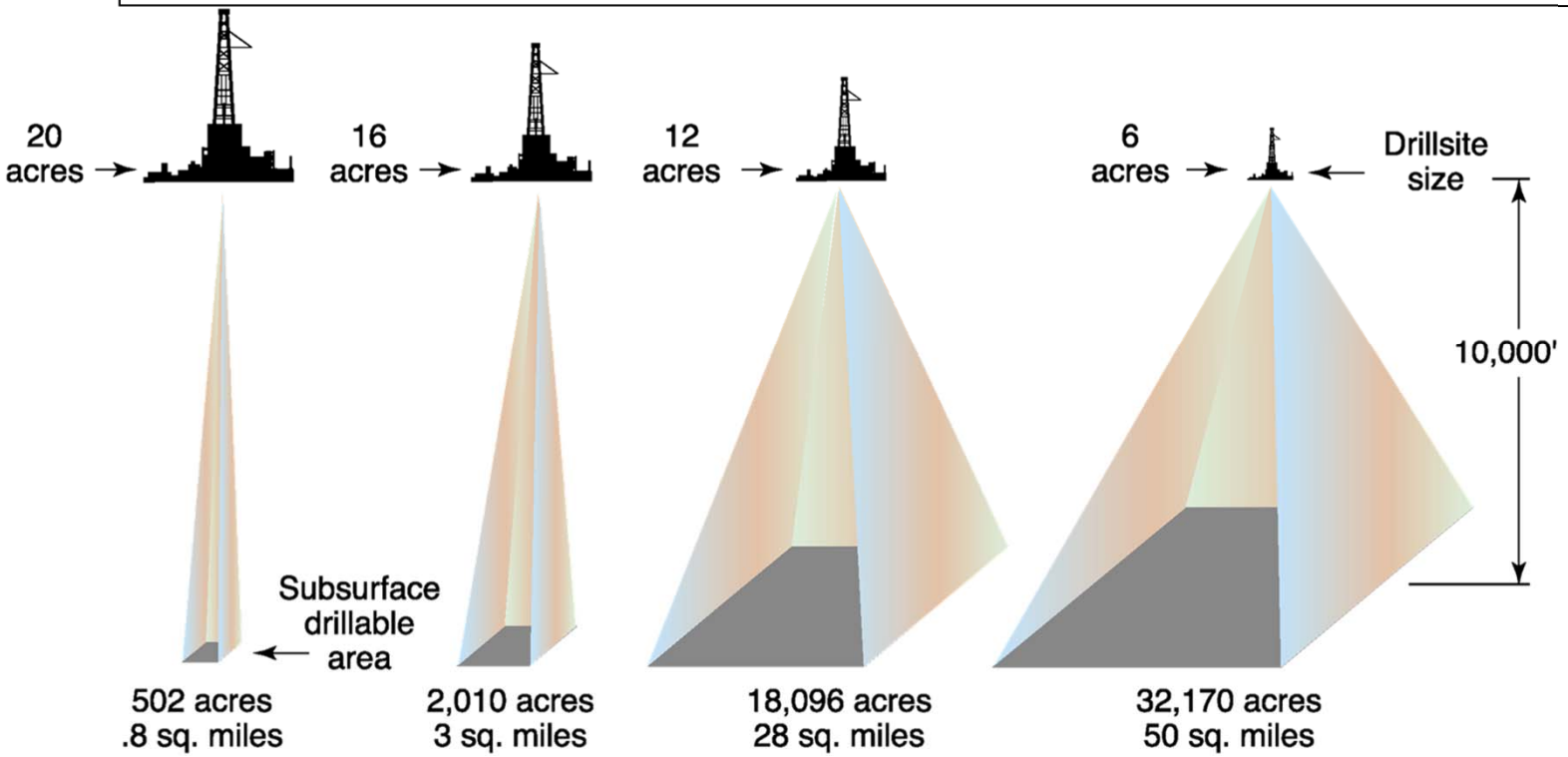
V

Access to Environmentally Sensitiv

- How to access with minimal impact
- How to measure effect of low-impact practices

Questar using "Pod" drilling

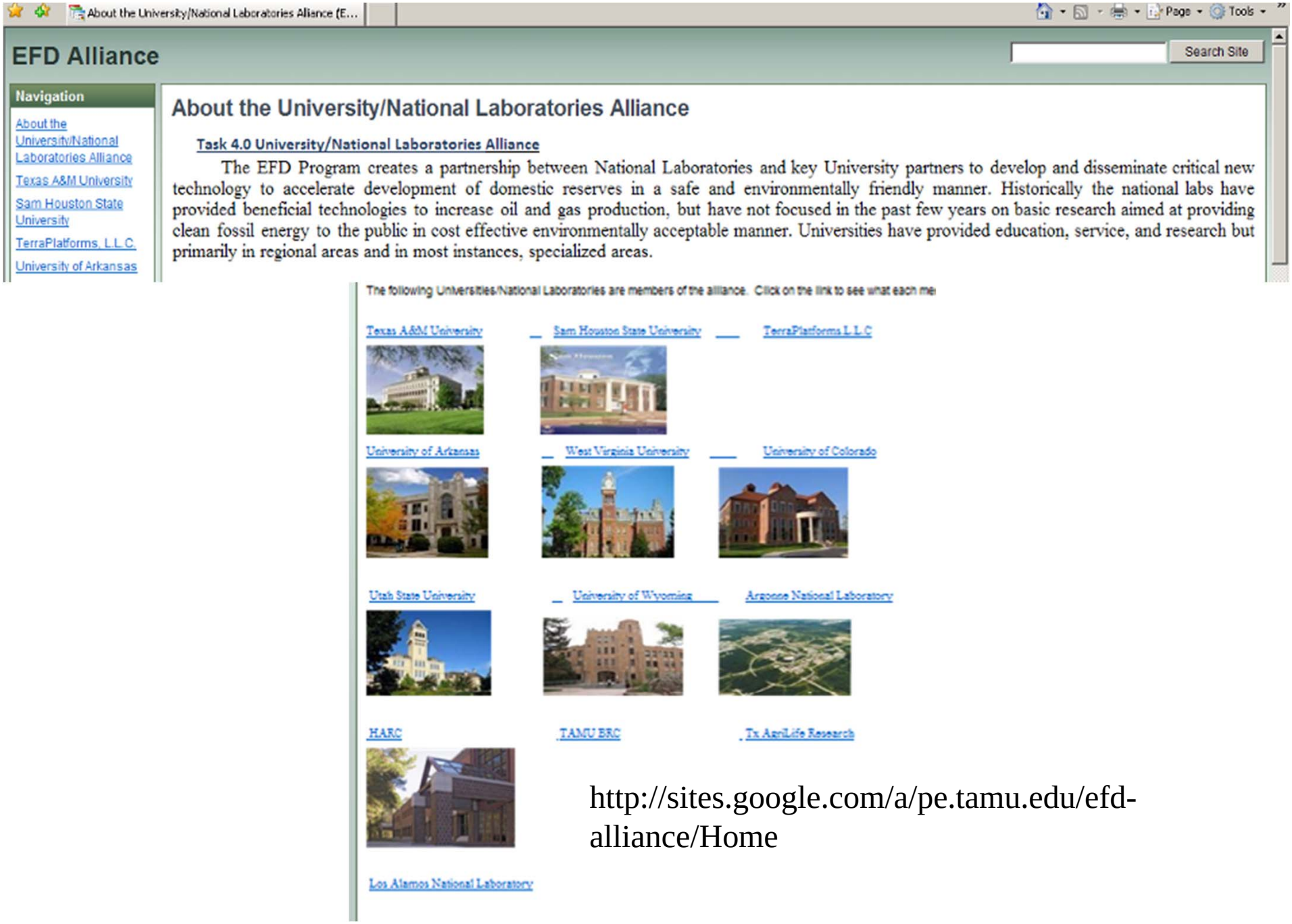
(1 acre per well.)



Source: William Harrison, Kansas Geological Survey

Barnett Shale Well Pad – Fort Worth Texas

The Technology Partners EFD Program 2010



http://sites.google.com/a/pe.tamu.edu/efd-alliance/Home

Societal Acceptance
(Utah State Univ./Sam Houston State)

- **Develop understanding of the environmental and social impacts that gas development in the Uinta Basin.**
- **Identify opportunities and barriers to expanded use of EFD approaches in the Uinta Basin.**

Deliverables

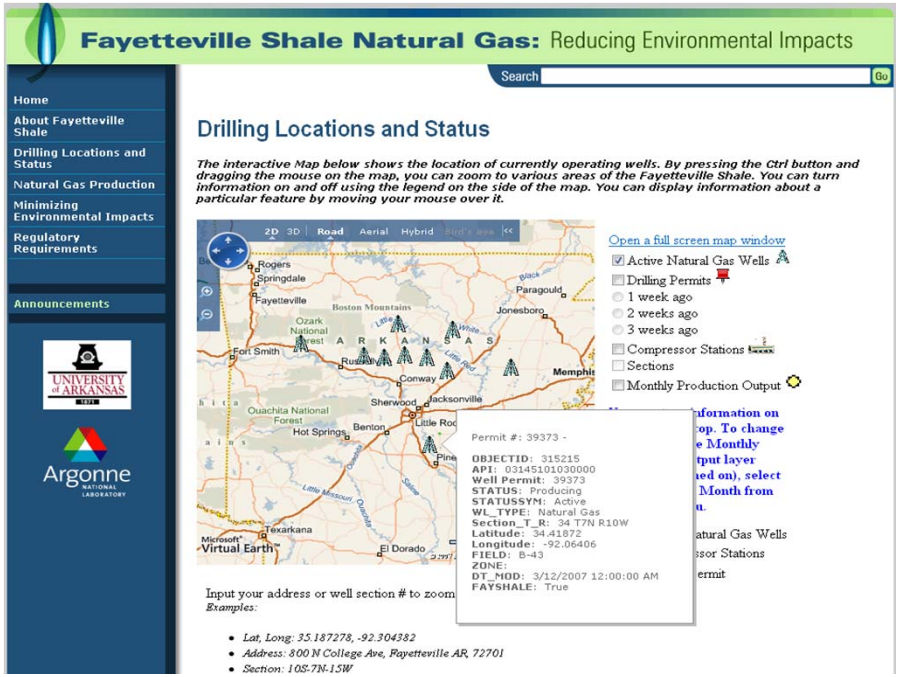
- White paper summarizing needs/barriers for the region.
- Fact-sheets and other materials discussing EFD applications.
- Workshops will be held to ensure that the technologies are effectively transferred.

Status

- Completed interviews with reps from industry, state agency and nonprofit sectors.
- Gathered documentation about regulatory rules & procedures at state, tribal and federal level.

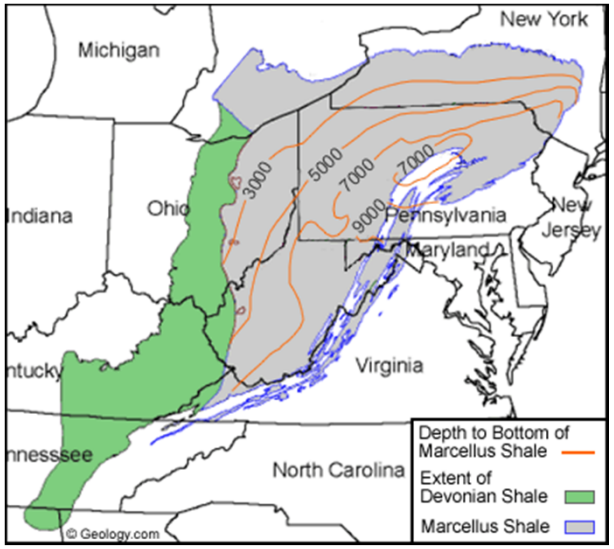
University of Arkansas: Fayetteville Shale

Probabilistic Risk-Based Decision Support for Oil and Gas Exploration and Production Facilities in Sensitive Ecosystems



http://lingo.cast.uark.edu/LINGOPUBL

Eastern Mountain States Studies (West Virginia University)



Initiate an environmentally friendly E&P systems program for the Marcellus Shale Basin.

Deliverables

- White paper summarizing the needs and barriers associated with developing the Marcellus play.
- Series of workshops to transfer new EFD technology for developing the Marcellus play.

Status

- Continued planning for workshop – wk of 8/23.
- Will have a field trip to well locations in NY that are implementing research results/best practices.

Huisman Small Footprint Drilling Rig

Small footprint drilling rig to investigate reduction in environmental impact

EFD Activities

- Documenting prototype test of low impact rig.

Partners

- ***Huisman Rig***
- ***Zero Spill Technologies***
- ***Waste Heat – Electricity***

- LOC 400 movie uploaded to EFD web site.

Texas A&M Disappearing Roads

How do you make this road disappear?

Disappearing Roads Competition.

http://www.DisappearingRoads.com

$10,000 1st Place
$7,000 2nd Place

NOx Air Emissions Studies

Develop guidelines concerning the measurement of oxides of nitrogen (NOx) for a drilling site and work with operating company personnel to plan an investigation at a location.

Deliverables

- Plans for an emissions study.
- Guidelines for emissions reduction of large engines.

Status

- Kicked off effort to develop guidelines.
- Guidelines incorporated into Scorecard Reference Guide.

Reduced Fracturing Footprints

Identify alternatives to reduce the footprint including offsite operations and innovative fracturing technologies such as a novel process involving: minimal pumping equipment, low volumes of frac fluid and materials that are environmentally green and non-damaging.

Deliverables

- Report documenting alternatives to reduce the footprint of hydraulic fracturing operations.

Status

- ***Will hold workshop to identify Hydraulic Fracturing Scorecard parameters.***

Waste constituent

Produced water:

- Water
- Chemicals (and heavy metals)
- Low-solids percentage and distribution
- hydrocarbons
- Varies by location
- Some sort of separation from oil is usually done

Drilling Wastes

- Water
- High solids (~ 5-8% by volume)
- Chemicals (mud additives)
- Lower Hydrocarbons concentration
- Miscellaneous

Reverse Osmosis Definitions (RO)

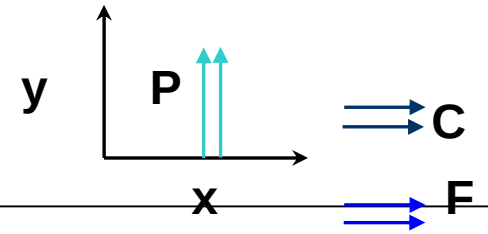
$R = 1 - C_P / C_F$ Salt rejection

Transmembrane pressure

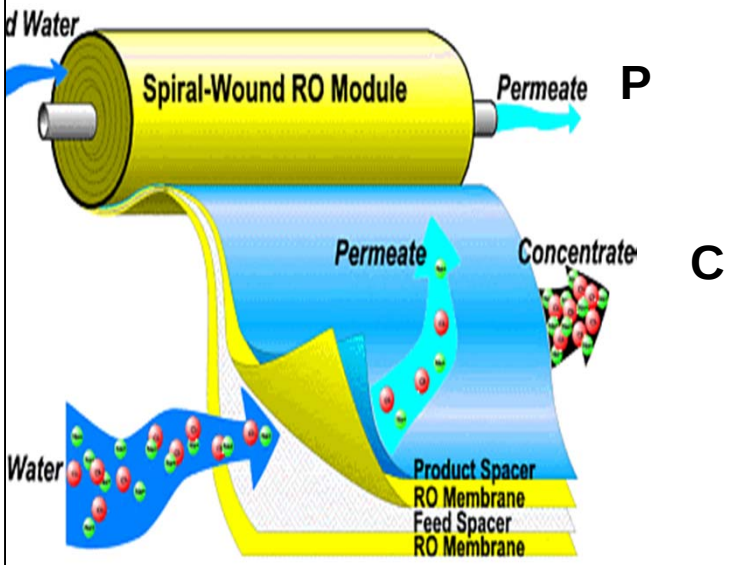
Feed, permeate, reject or concentrate rates

Fluxes (volumetric rate/area)

Feed Flux: $J_F = Q_F / A$

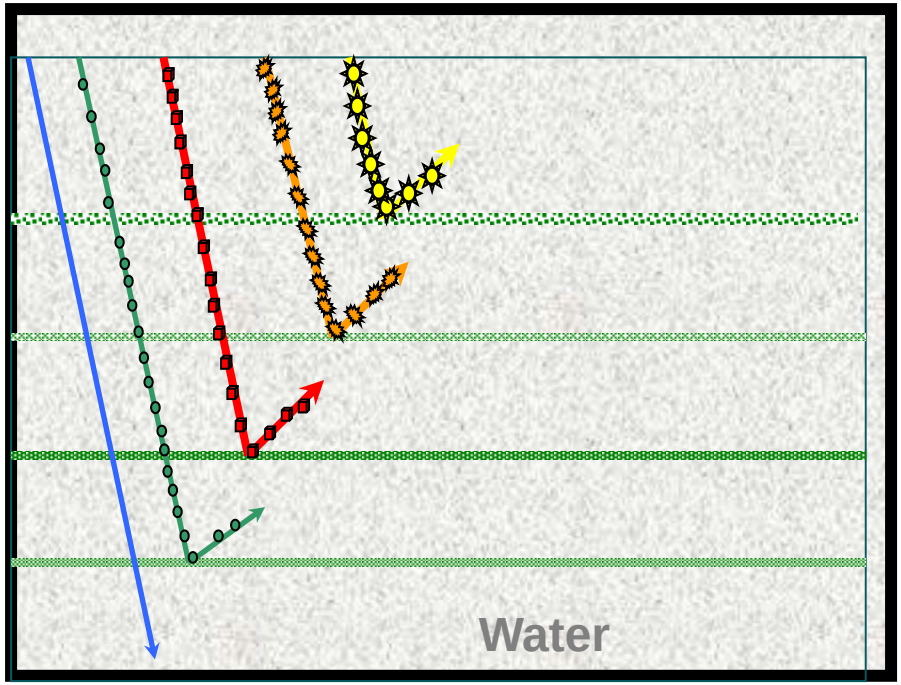


$$TMP = \left[\frac{P_F + P_R}{2}\right] - P_P$$



Task 3

Identifying Key Technology Components



Micro Filtration (MF) (10-0.1μm)
Bacteria, suspended particles

Ultrafiltration (UF) (0.05-0.005μm)
Colloids, macromolecules

Nanofiltration (NF) ($5e^{-3}$-$5.e^{-4}$ μm)
Sugars, dyes, divalent salt ppts.

Reverse Osmosis (RO) ($1.e^{-4}$-$1e^{-5}$ μm)
Monovalent salts, ionic metals

Comparison of Desalinated Produced Water with Municipal Water from College Station. TX

ide	54	706	1
e	9	3	ND
g, K, Na, B	203	94 ppm	1.3
olved			
m, etc	2 ug/L	0.9 mg/L	ND
ganics			
oform, +	14 ug/L	3.4 ug/L	85 ug/L

Facilities: Separation Sciences Laboratory

Mobile Pre-Treatment and Desalination Unit at Boonville Texas Site. (2009)

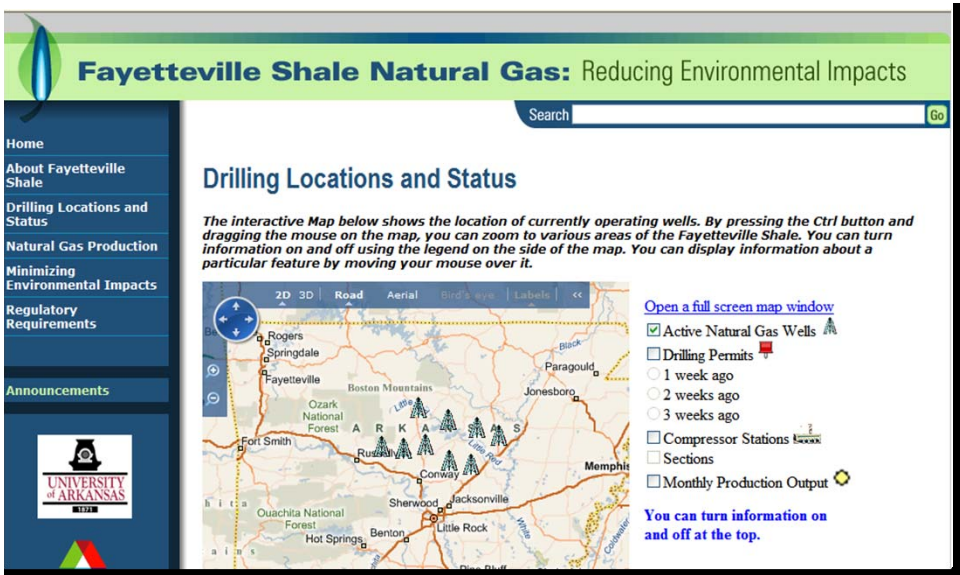
All Weather Mobile Unit for Site Treatments (2011)

- **A view of the mobile testing laboratory.**

Mobile Unit Interior (2011)

- *The mobile training unit capabilities:*
  - *bench top membrane efficacy tests,*
  - *Oil removal testing*
  - *TSS Removal*
  - *TDS Removal*
  - *Membrane Cleaning*
  - *Analytical monitoring*

Dissemination and Decisions Support (University of Arkansas)



Develop a website for the Haynesville Shale that describes the natural gas resources available and their development and provides information about the state and federal regulatory requirements that developers must follow.

Deliverables

- Work with stakeholders from at least one other play to deploy an information site using this framework and document the process so that it could more easily be deployed elsewhere.

Status

- ***Presentation to be given.***

Best Practices Database (University of Colorado)

Develop a free-access, searchable, database and supporting website for best management practices (BMPs).

Deliverables

- Take the beta version to a broader community of partners to refine and expand its functionality, add BMP data, and develop additional website support materials. Materials featured on the website will include projects of the EFD team and its alliance partners.

Status

- Summer staff (6 undergrad, 2 interns, 2 law students) hired to expand website and database
- Summer emphasis will include case studies, BMP efficacy, cost/benefit analysis, and law materials
- New promotional flier
- Pre-proposal submitted to foundation for funding of companion human health laws project

Reduced Surface Footprint

Texas A&M University Disappearing Roads University Competition

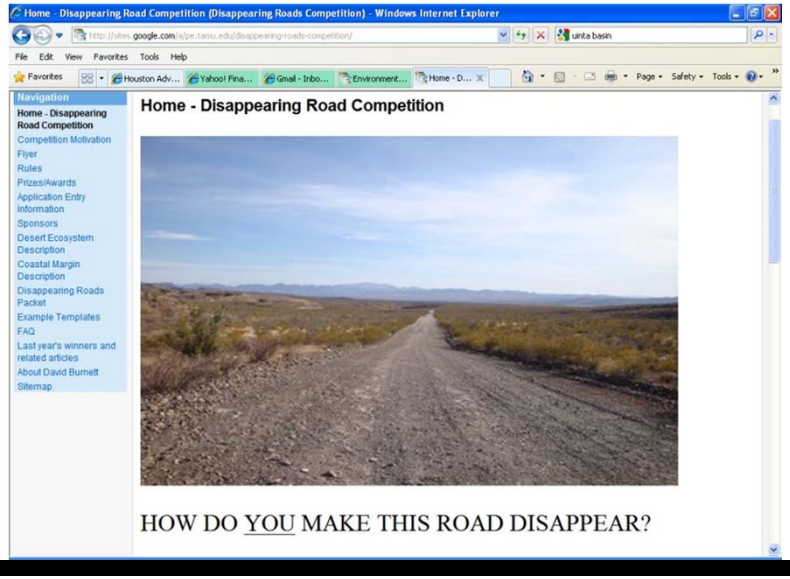
Scott Environmental Services – Recycle – Reuse Newpark Integrated Mats

Heartland Biocomposites – U of Wyoming Roll out Roads

Pecos Desert Test Center

Approximately ½ mile

Disappearing Roads



Support the Disappearing Roads Competition.

Deliverables

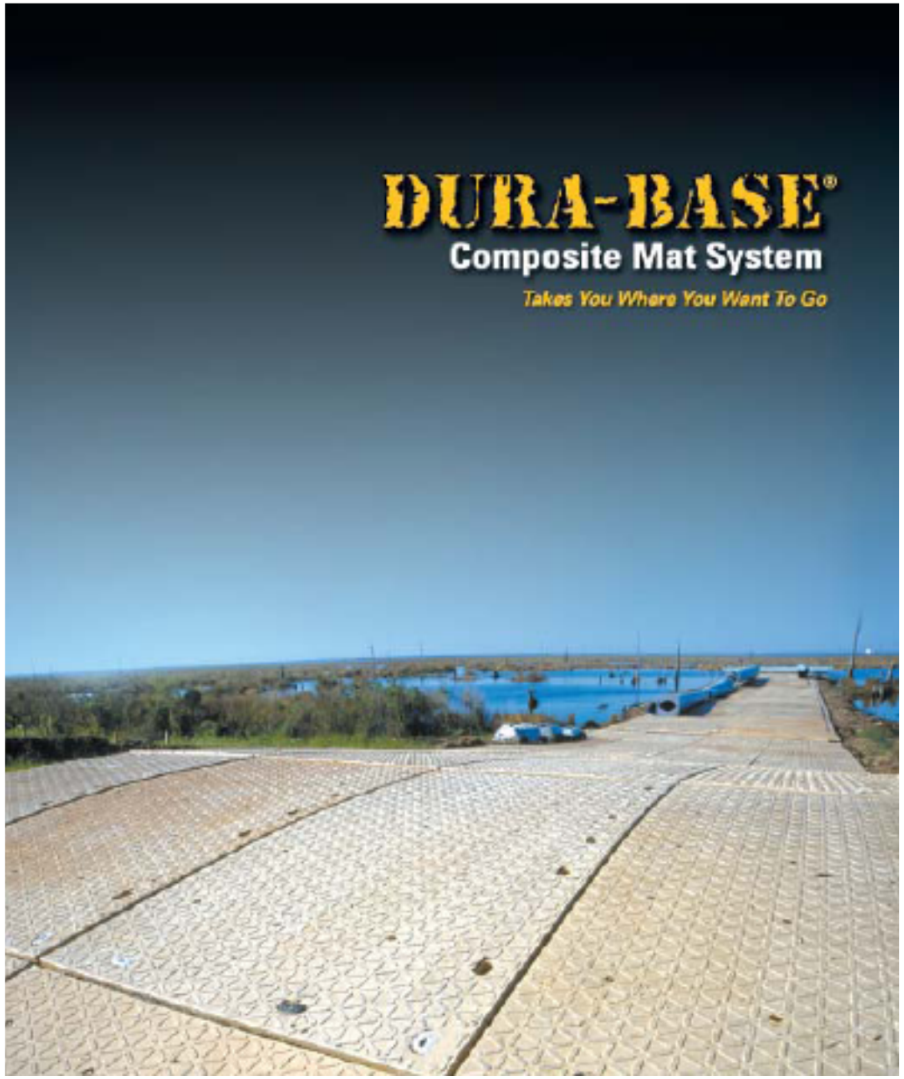
- Support to the competition.

Status

- Finals held on May 26th.
- ***Separate presentation to be made.***
- ***PTTC will institutionalize program!***

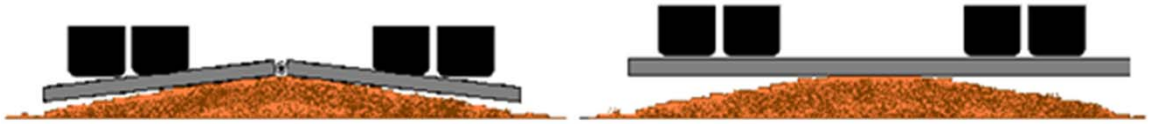
Scott Environmental Services Recycled Drill Cuttings Road Base

DURA-BASE® COMPOSITE MAT SYSTEM



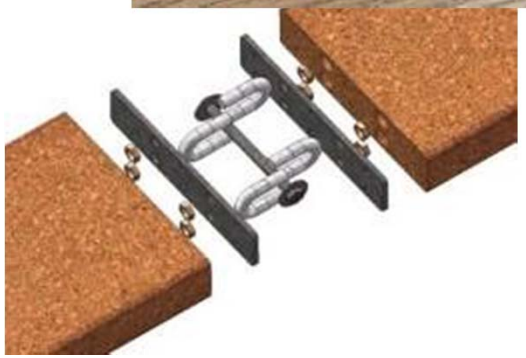
Laying Down Composite Mats

U of Wyoming – Heartland Biocomposites Rollout Road



- Main Components
  - Conformable

  - Hinged board segments



- Field Test

The Environmentally Friendly Drilling Technology Integration Program

Reducing Impacts of Oil & Gas Development on Rangelands in Western U.S.

David Burnett – Texas A&M University
Richard C. Haut – Houston Advanced Research Center
Tom Williams – AFS Solutions Inc.
Gene Theodori - Sam Houston State University
John Veil – Argonne National Laboratory

Texas A&M Vernal Utah
October 14, 2010

Texas A&M University

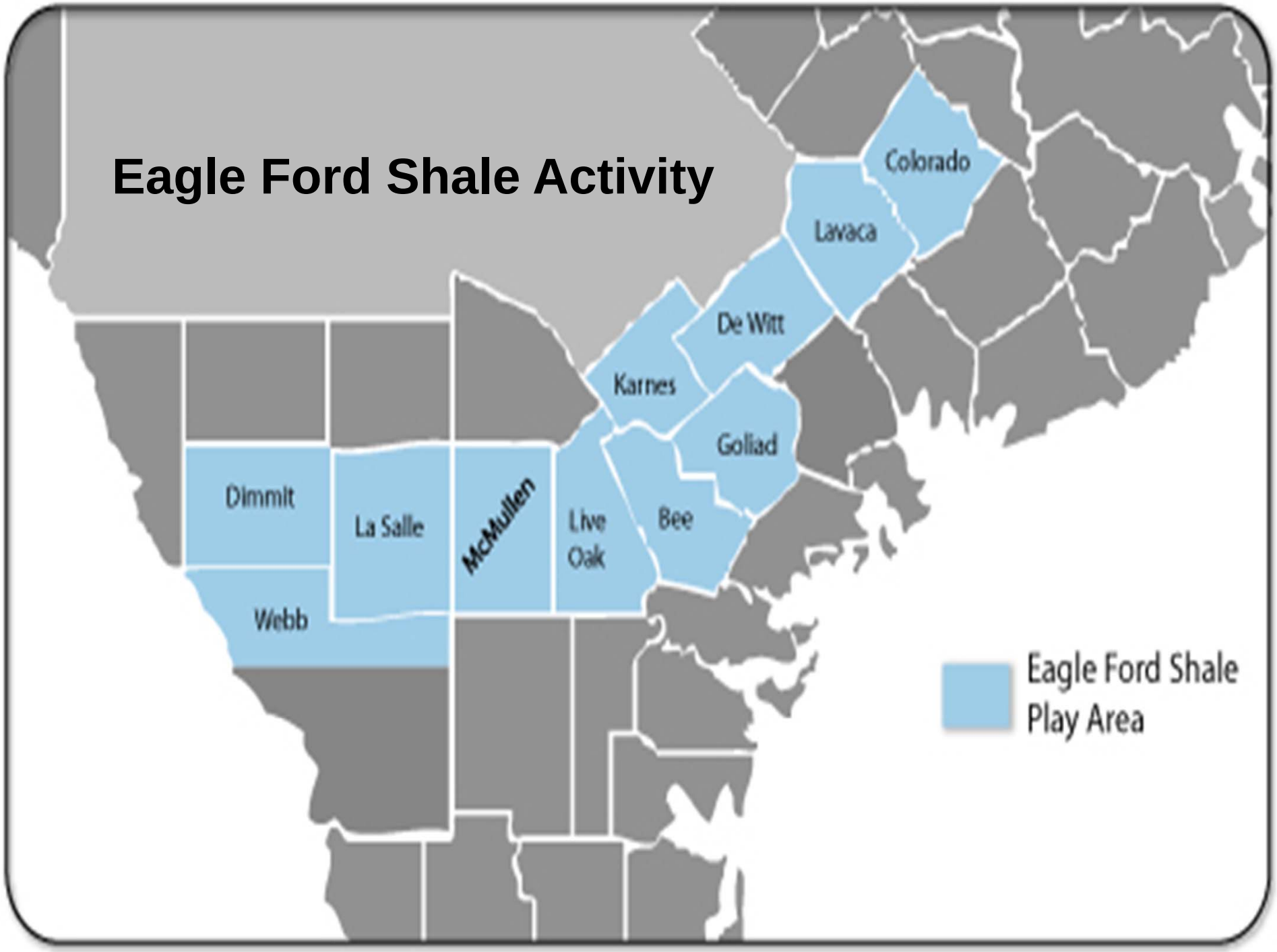
HARC

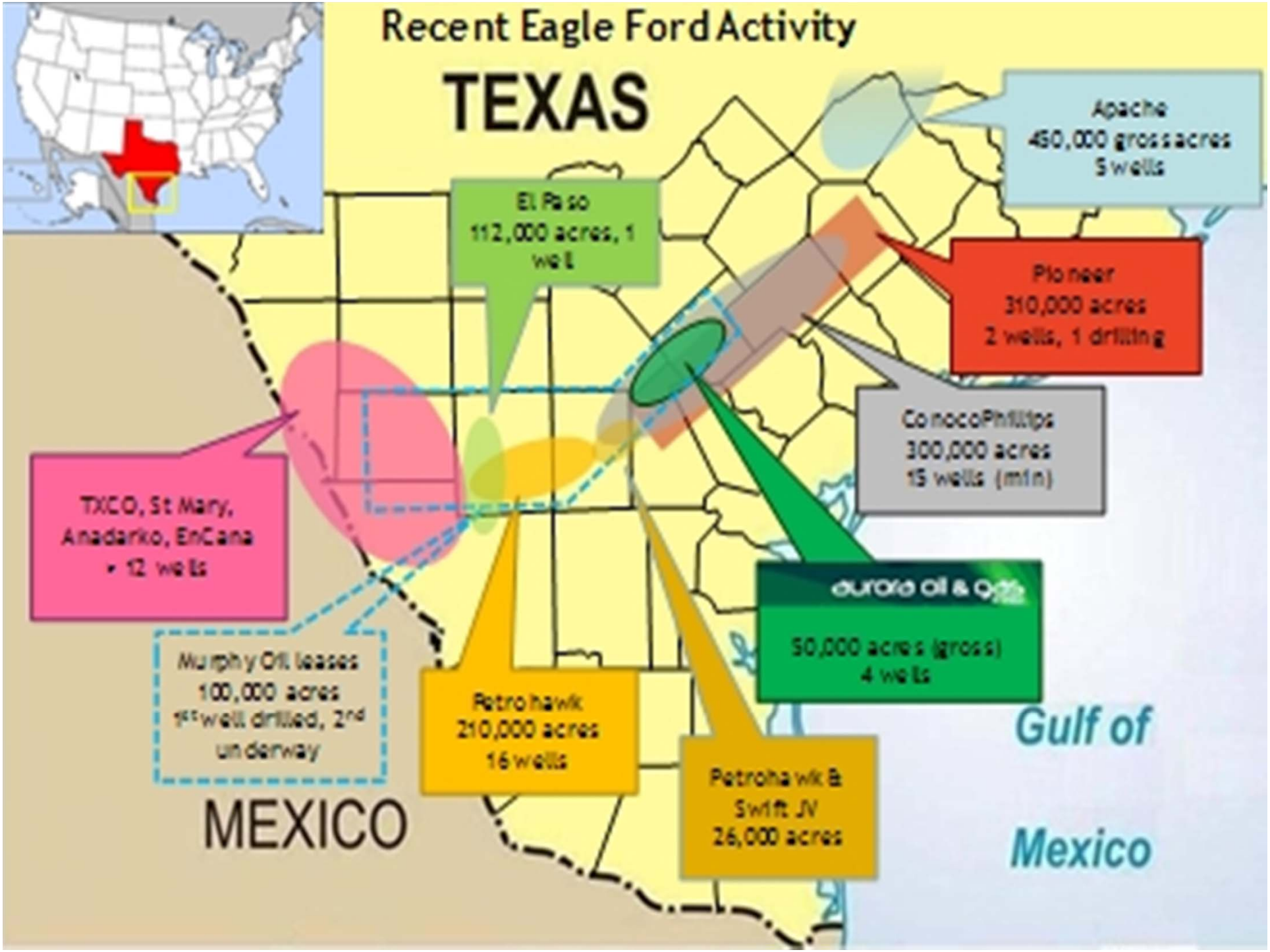
The EFD TIP in the Eagle Ford Shale

Objectives: ***The Technology Integration Program is an integrated approach for applying new technologies in the production of unconventional natural gas.***

Target Proving Ground: ***The Eagle Ford Shale***

The Goal: **To create a program that would *speed the commercial development* of technology developed through RPSEA programs.**


Eagle Ford Shale Activity
Colorado
Lavaca
De Witt
Karnes
Goliad
Bee
Live Oak
McMullen
La Salle
Dimmit
Webb
Eagle Ford Shale Play Area


Recent Eagle Ford Activity
TEXAS
Apache
450,000 gross acres
5 wells
El Paso
112,000 acres, 1 well
Pioneer
310,000 acres
2 wells, 1 drilling
ConocoPhillips
300,000 acres
15 wells (min)
TXCO, St Mary, Anadarko, EnCana
• 12 wells
aurora oil & gas
50,000 acres (gross)
4 wells
Murphy Oil leases
100,000 acres
1st well drilled, 2nd underway
Petrohawk
210,000 acres
16 wells
Petrohawk & Swift JV
26,000 acres
MEXICO
Gulf of Mexico

http://efdsystems.org

Thanks – Questions?

http://www.GPRI.org

http://sites.google.com/a/pe.tamu.edu/efd-alliance/Home

http://www.TAMUEagleFordShale.com