ENVIRONMENTAL BEST PRACTICES FOR SHALE GAS DEVELOPMENT

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WORKSHOP PREPARATIONS

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- Interstate Oil & Gas Compact Commission

THANK YOU!

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WORKSHOP OUTLINE

• Introduction – BMP objectives
• Considerations in Selecting BMPs
• Discussion by phase of development: planning, siting, drilling, stimulation/completion, operations, reclamation:
  – BMP options – how to select an appropriate BMP
  – Tradeoffs or unintended consequences
• Resources
INTRODUCTION
Best Management Practices (BMPs)

Definition of BMPs:

• Technologies, methods, and procedures that avoid, reduce, or mitigate environmental and community impacts associated with oil and gas activities

• BMPs are proactive and can also be reactive:
  – Often best incorporated early in a project
  – Site specific
  – Economically feasible

• BMPs are not required, but often allow an operator to meet a regulatory requirement
WHAT BMPs ARE NOT

• *Not* – *An assurance of 100% impact avoidance*
  – Some degree of impact is unavoidable if the gas resource is to be produced

• *Not* – *Universally applicable*
  – What works in Texas may be totally inappropriate for New York

• *Not* – *One-size-fits-all*
  – Multiple BMP options may address the same basic concern from different approaches or under different circumstances
Purpose of BMPs

Addressing the environmental hierarchy, BMPs are used to effectively:

• Avoid environmental impacts
• Minimize environmental impacts
• Mitigate those environmental impacts that are unavoidable
OBJECTIVES FOR BMPs

• Environmental
  – Regulatory requirements
  – Environmental stewardship/responsibility

• Health and safety
  – On-site workers
  – General public

• Community relations
  – Quality of life
CONSIDERATIONS IN SELECTING BMPs
# Considerations in Selecting BMPs

As they say in real estate, it’s all about “*location, location, location*”

<table>
<thead>
<tr>
<th>Physical Characteristics:</th>
<th>Regulatory/Public Concerns:</th>
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<tbody>
<tr>
<td>• Topography including:</td>
<td>• Air emissions</td>
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<tr>
<td>– Potential for erosion and sedimentation</td>
<td>• Sensitive environments</td>
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<tr>
<td>– Pre-existing surface conditions</td>
<td>• Threatened and endangered species</td>
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<td>• Climate</td>
<td>• Viewsheds</td>
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<tr>
<td>• Geology</td>
<td>• Demographics</td>
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<td>• Hydrology – protection of surface and ground waters</td>
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ADDITIONAL CONSIDERATIONS

• BMPs can have both positive and negative impacts:
  – Identify impacts and appropriate responses early
  – Identify additive, synergistic, and countervailing effects
• Plan with an environmental protection objective in mind and overall need based on the location and situation
• Consider a cradle-to-grave approach
• Synergistic opportunities can address multiple impacts over the life of a project
BMPs may entail trade-offs:
- Centralized water reservoirs may reduce water withdrawal issues but may result in additional surface disturbance and truck traffic

Watch for unintended consequences:
- Water impoundments may benefit wildlife, but may also increases mosquito populations
EVOLUTION OF BMPs

• BMPs have been around a long time, but weren’t compiled until recently
• Started as good ideas shared within companies or between small operators
• Early compilations included:
  – NYDEC’s BMPs for visual impacts in 2000
  – ALL Consulting’s CBM Best Practices in 2003
  – BLM’s BMPs for federal lands 2004
  – Western Governors Association’s CBM BMPs - 2006
  – Many others have followed
DISCUSSION BY PHASE OF DEVELOPMENT
**Approach to Shale Gas BMPs**

BMPs will be discussed by development phases:

- Project planning
- Siting (site-specific)
- Drilling
- Stimulation/Completion
- Operations
- Reclamation – interim and final

View of second drilling location adjacent to intermittent stream.

Intermittent Stream Corridor

Designed to avoid earthwork disturbances to hill

Preferred location
SHALE GAS BMPs DISCUSSION

• For each developmental phase we will use example BMPs to discuss:
  – Considerations for choosing BMPs
  – BMP options
  – Decision criteria and tradeoffs
  – Participant problems and situations that could be addressed with BMPs

• Please, ask questions as we go
Project Planning Phase
PROJECT PLANNING CONSIDERATIONS

Employ a lifecycle project planning approach:

• Identify environmental issues and potential BMP solutions early in the project (planning phase)
• Develop a project timeline for the most effective implementation of BMPs
• Consider that a few broad-reaching BMPs may more effectively address many issues across several phases versus a greater number of issue-specific or phase-specific BMPs
• Anticipate potential project evolutionary events that require identification and implementation of BMPs in the future
Employing multi-well pads has broad implications across all development phases:

- lower construction costs
- less surface disturbance
- less habitat fragmentation
- fewer roads and utility corridors
SITING PHASE
SITING CONSIDERATIONS

- Topography: steep slopes, storm water runoff, spill pathways
- Potential for erosion and sedimentation
- Road placement and construction
- Water protection: groundwater and surface water (e.g. lakes, streams, rivers, wetlands)
- Sensitive environments: floodplains, riparian areas, wetlands, parks
- Threatened and endangered species/sensitive species habitat
- Viewsheds
- Demographics: suburban or rural
- Infrastructure: availability and proximity
MULTI-WELL PAD EXAMPLE

Siting Impacts

- Reduced surface disturbance
- Fewer roads and utility corridors
- Easier to avoid sensitive environments and infrastructure
- Moves impacts (noise, visual, etc.) to a smaller area
- Easier to mitigate
  - Con: Concentrates impacts
- Economy of scale
SITING

EROSION AND SEDIMENTATION CONTROL

• Silt fence
• Hay bales
• Mulch
• Earthen berms
DECISION CRITERIA

EROSION AND SEDIMENTATION CONTROL

• Cost
• Ease of implementation
• Effectiveness
• Durability/maintenance
• Regulatory drivers
• Are there environmental trade-offs?
Drilling Phase
Drilling Considerations

- Surface disturbance
- Air emissions
- Pit reclamation
- Traffic
- Noise
- Visual impact
MULTI-WELL PAD EXAMPLE

Drilling Impacts

- Rig stays on one site
- Less noise, emissions, etc. from rig mob/de-mob
- Less traffic
- Centralized drilling waste management
  - Fewer pits
  - Easier disposal and reclamation
Drilling
Noise Reduction

• Local terrain / vegetation
  – Must be selected in planning phase
• Sound barrier technology
• Alternative Equipment
DECISION CRITERIA

NOISE REDUCTION

• Cost
• Ease of implementation
• Effectiveness
• Equipment availability
• Regulatory barriers
• Other advantages/synergies (trees as a noise barrier may provide visual relief)
• Are there environmental trade-offs?
Stimulation/Completion Phase
STIMULATION / COMPLETION CONSIDERATIONS

• Water management:
  – Fresh water volumes:
    • Location of withdrawal
    • Timing of withdrawal
    • Storage
  – Wastewater volumes:
    • Flowback water storage
    • Treatment / disposal
    • Recycling

• Control of invasive species

• Transportation
  – Trucks – traffic and impact to roads
  – Temporary surface pipelines

• Groundwater protection

• Flaring – air emissions
MULTI-WELL PAD EXAMPLE

STIMULATION / COMPLETION IMPACTS

• Easier for central water storage
• Less truck traffic
• Easier, centralized management of flowback water
• More practical for pipeline transport of water
  — Even less truck traffic
Well Stimulation/Completion Water Withdrawals

- Flow-based withdrawals
- Reuse of flowback water
- Use of lesser quality water sources
DECISION CRITERIA

WATER WITHDRAWALS

These BMPs are not mutually exclusive

• Cost
• Ease of implementation
• Effectiveness of reused or lesser quality water
• Availability of alternative sources
• Regulatory barriers (Q7 – 10, in-stream flows)
• Are there environmental trade-offs?
Production/Operations Phase
PRODUCTION/OPERATIONS

CONSIDERATIONS

• Surface disturbance (partial reclamation)
• Erosion and sedimentation control
• Produced water treatment and disposal
• Air emissions from stationary equipment
• Visual impacts
• Traffic:
  – Congestion
  – Impact on roads
  – Increased air emissions
• Noise
MULTI-WELL PAD EXAMPLE

Production / Operations Impacts

• Easier erosion control
• Centralized produced water management
• Easier to minimize and mitigate noise and visual impacts
• Less traffic
• Simplified interim reclamation during production

Six (6) acre location with eight (8) wellheads, separation and power facilities, flowlines, and a perimeter fence.
Well Production/Operations

Air Emissions Control

- Use natural gas-fired engines in place of diesel
- Use electric compressors powered from the grid
- On-site electric generation using one lean-burn engine instead of several rich-burn engines
**Decision Criteria**

**Air Emissions Control**

- Cost
- Access to grid
- Effectiveness
- Equipment reliability
- Regulatory drivers
- Are there environmental trade-offs?
  - moving the site of emissions?
RECLAMATION CONSIDERATIONS

Employ a lifecycle project planning approach:
• Minimizing disturbance during production
  – Interim reclamation facilitates more effective final reclamation
• Controlling noxious weeds
• Reclamation of impoundments
• Long-term use
  – Original contour
• Land owner preference
MULTI-WELL PAD EXAMPLE

Reclamation

• Smaller overall footprint – siting decision payoff
  – Less habitat loss
  – Less habitat fragmentation
  – Less total area to reclaim

• Economies of scale
RECLAMATION
RE-VEGETATION

• Habitat creation
  — PA rattlesnakes, deer, etc.
• Use of native species
• Use of seed source free of noxious weeds
• Plant mature shrubs and trees
Decision Criteria
Re-Vegetation

These are not necessarily mutually exclusive

• Cost
• Ease of implementation
• Land owner preference
• Lease terms
• Regulatory barriers
• Are there environmental trade-offs?
SUMMARY AND RESOURCES

[Map of US Shale Gas Plays and Basins]
SUMMARY

• Plan ahead
• Consider what works best in your situation
• Consider synergistic benefits of a single BMP
BMP RESOURCES

Federal Agency Links

  mer_2009.pdf
- http://www.epa.state.il.us/p2/fact-sheets/bmp-oil-exploration.html

State Agency Links

- http://www.forestry.state.ar.us/bmp/bmp_review.html

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BMP Resources

Association and Industry Links

- http://www.oilandgasbmmps.org/
- http://www.ipaa.org/issues/hot_topics/docs/RAPPS.pdf
- http://lingo.cast.uark.edu/LINGOPUBLIC/
- http://www.forestrybmp.net/
- http://www.bmpdatabase.org/
THE JOB IS NOT OVER
CONTINUED PUBLIC EDUCATION

• Factually characterize horizontal drilling and hydraulic fracturing
• BMPs – the public asks: “am I getting the best?”

“The Best” is site-specific
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