Hydrofracking and Engineering Issues
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Mark P. Millspaugh, P.E.
President
Sterling Environmental Engineering, P.C.
24 Wade Road
Latham, New York 12110
(518) 456-4900
www.sterlingenvironmental.com
mark@sterlingenvironmental.com

Larry Shilling
Regional Vice President
Casella Waste Systems
1879 Route 5 & 20
Stanley, New York 14561
(607) 277-4820
www.casella.com
larry.shilling@casella.com

Today's Presentation

- Drilling & Hydrofracking
- Legal & Regulatory Foundation
- Potential Environmental Impacts
- Role of Engineers in Planning Design & Implementation
- Perspectives on Management of By Products & Residuals and Recent Technology Development
- Local Government Perspective
- Business Opportunity

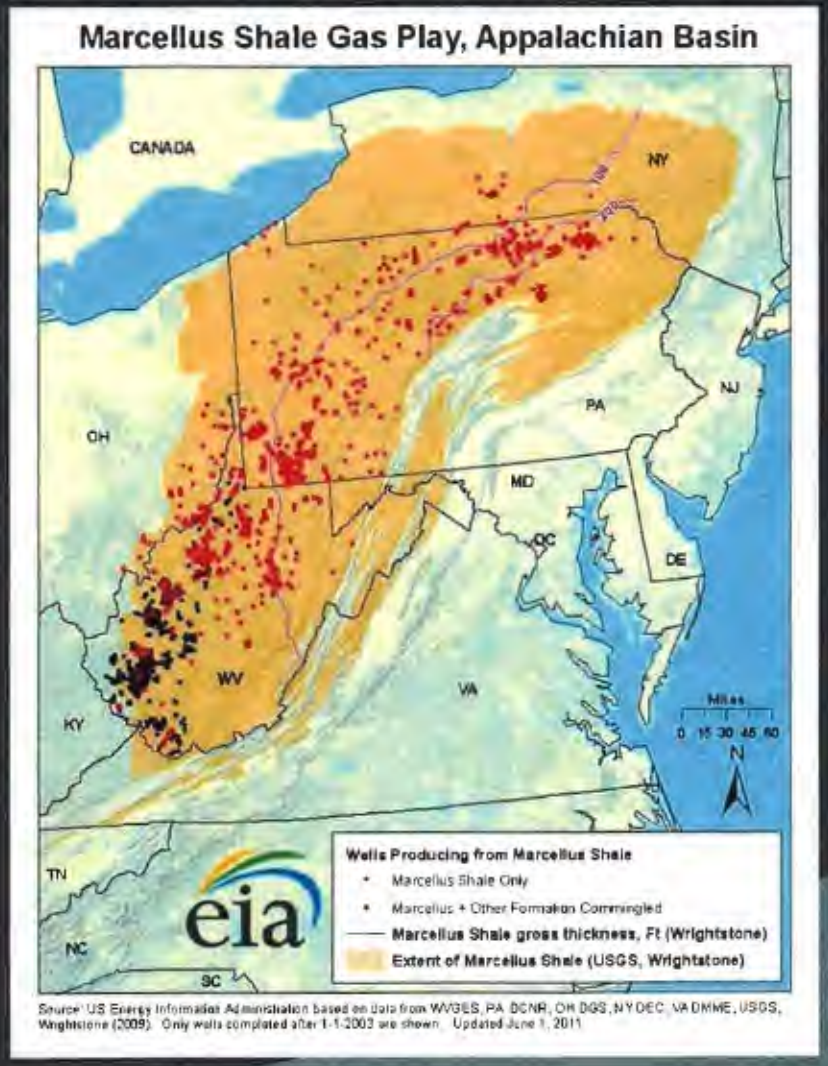
Borrowing from the Following Presentations

- Hydrofracking & Local Issues, Presented by Mark Millspaugh at NYS Association of Towns, February 2012
- Marcellus Shale Natural Gas Explanation in NY Regulatory Overview and Updated by Bradley Field, NYSDEC at Federation of NY Solid Waste Management Associations Meeting May 20, 2012
- Shale Gas Plays, Waste Disposal Implications by Larry Shilling, Casella Waste Systems presented at Federation of NY Solid Waste Management Associations Meeting May 20, 2012

Marcellus Shale

The Marcellus Shale formation stretches from New York to Ohio and West Virginia. Development has generally occurred in a "fairway" stretching from Scranton, PA to Charleston, WV.

HVHF not limited to Marcellus Shale

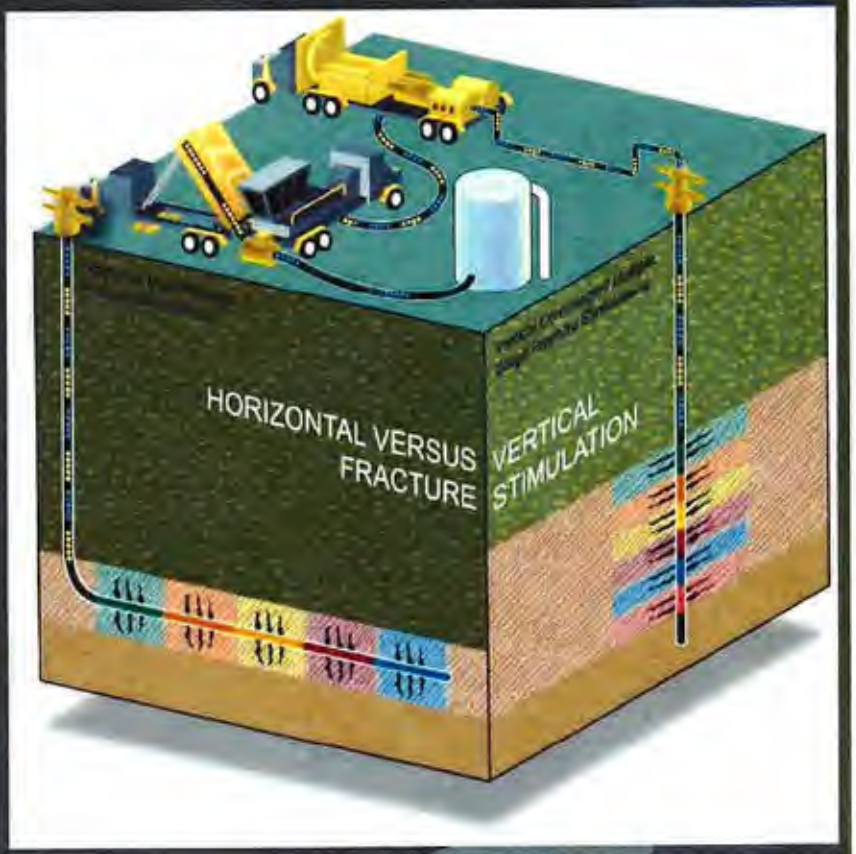


Oil and Gas Wells in New York

- Gas seeps: Lake Erie -1626
- Oil seeps: Cuba, NY - 1627
- First natural gas well: Fredonia, NY - 1821
  - Dug well near gas bubbles in creek
- First oil well: Allegany County -1863
- Est. 75,000 wells drilled since the 1820s
- 15,352 wells reported in 2010

Vertical and Horizontal Drilling

- First horizontal well: 1929
- First horizontal shale well: 1988 (Antrim Shale in Michigan)
- First NYS horizontal: 1989 (and hundreds drilled since)
- Makes multi-well pads possible



anada). A Primer for Understanding

High Volume Hydraulic Fracturing

Service companies pump large quantities of water, sand, and some chemicals down the wellbore and into the targeted formation to create the artificial fractures. The sand holds open or "props" the fractures which allows gas to flow into the well and up to the surface.

Environmental Conservation Law

Article 23 - MINERAL RESOURCES
- Title 1 - (23-0101 - 23-0102) DEFINITIONS
- Title 3 - (23-0301 - 23-0313) GENERAL PROVISIONS
- Title 5 - (23-0501 - 23-0503) WELL PERMITS AND WELL SPACING IN OIL AND NATURAL GAS POOLS AND FIELDS
- Title 7 - (23-0701) VOLUNTARY INTEGRATION AND UNITIZATION IN OIL AND NATURAL GAS POOLS AND FIELDS
- Title 9 - (23-0901) COMPULSORY INTEGRATION AND UNITIZATION IN OIL AND NATURAL GAS POOLS AND FIELDS
- Title 11 - (23-1101 - 23-1103) LEASES FOR PRODUCTION AND STORAGE OF OIL AND GAS ON STATE LANDS
- Title 13 - (23-1301 - 23-1307) UNDERGROUND STORAGE OF GAS
- Title 17 - (23-1701 - 23-1727) LIQUEFIED NATURAL AND PETROLEUM GAS
- Title 19 - (23-1901 - 23-1903) OIL, GAS AND SOLUTION MINING REGULATION AND RECLAMATION FEE
- Title 21 - (23-2101) INTERSTATE COMPACT TO CONSERVE OIL AND GAS
- Title 23 - (23-2301 - 23-2311) REREFINING OF USED OIL
- Title 24 - (23-2401 - 23-2402) NEW YORK STATE OIL ENERGY CONSERVATION PROGRAM
- Title 27 - (23-2701 - 23-2723) NEW YORK STATE MINED LAND RECLAMATION LAW

6NYCRR Chapter V Resource Management Services Subchapter B: Mineral Resources

- Part 550: Promulgation and Enforcement of Rules and Regulations
- Part 551: Reports and Financial Security
- Part 552: Permits To Drill, Deepen, Plug Back or Convert Wells
- Part 553: Well Spacing
- Part 554: Drilling Practices and Reports
- Part 555: Plugging and Abandonment
- Part 556: Operating Practices
- Part 557: Secondary Recovery and Pressure Maintenance
- Part 558: Transportation
- Part 559: "Bass Island" Regulations

Significant Issues

- Political
- Social
- Economic
- Governmental
- Energy Policy
- Property Rights
- Environmental
  - Drinking Water
  - Air Resources
  - Community Character

Complex statutory and regulatory framework.
Overlapping jurisdictions.

Preemption

- ECL 23-0303(2)

  "The provisions of this article shall supersede all local laws or ordinances relating to the regulation of the oil, gas and solution mining industries; but shall not supersede local government jurisdiction over local roads or the rights of local government under the real property tax law."
- Preemption has been challenged by several municipalities in New York State litigation testing the validity of locally imposed drilling bans is ongoing.

Local Authority

- Town Granted Authority to Regulate Land Use, Business Activities, and Local Quality of Life Issues
- Land Use Plans
- Wetlands and Critical Environmental Areas
- Flood Plains
- Aquifers
- Historic and Archeological Resources
- Utilize Existing Site Plan Review Process?

SEQRA Review Process

- EAF
- Local Approvals
- Coordination with NYSDEC
- Development of Site Specific Permit Conditions
- Adopt Findings
- Notification to Local Government
- Agricultural Districts

Storm Water Pollution Prevention Plans

- Multi-Sector General Permit
- SWPPP
- Town is Responsible to Operate and Maintain Storm Water Systems Along Roads
- Potential Impact on Town Drainage Facilities
- MS4 Responsibility

Emergency Response Planning

- Town Must Have Ability to Respond to Emergencies
- Fire and Ambulance Personnel Must be Familiar with Site Conditions
- Preplanned Coordinated Responses

Ancillary Issues

- Anticipate Ancillary Activities
  - Water Taking Locations and Associated Traffic
  - Laydown, Staging and Parking Areas
- Towns have Authority to Review and Approve Changes to Private Land through Zoning and Site Plan Review
- Long Term Drilling May Induce Secondary Development

Generic Environmental Impact Statement

- Evaluates separate actions having common impacts
  - Individual EIS not needed if GEIS adequately addresses all potential impacts
  - Still an individual permit after site and technical review
  - Supplemental EIS needed for if potentially significant impacts not addressed
- Gas well drilling in NYS was reviewed in a 1992 GEIS
  - 12-year effort; four-volume, *937-page* document
- Potential shale-related impacts not addressed by GEIS
  - High-volume fluid management
  - Multi-well pad drilling

SGEIS Process – recent events

- September 30, 2009: Draft SGEIS published
  - 800+ pages, 587 refs.
- December 31, 2009: Comment period closed
  - Four DEC hearings + three additional transcripts submitted
  - > 13,000 written comments, including technical reports
- January 2011: Executive Order No. 41 continued
  - DEC to publish a Revised Draft Supplemental Generic Environmental Impact Statement (rdSGEIS)
- September 2011: 2011 rdSGEIS released
  - 120-day public comment period
- October 2011: Draft regulations issued
- November 2011: 4 public hearings held
- January 11, 2012: Comment period closed
  - > 67,000 comments and reports received and being processed

Comment Review Process

- Currently processing the 13,000 comments from 2009 and the 67,000 comments from 2011
- Comments range from post card campaigns and crayon drawings to scientific studies and lengthy reports
- Online comment system and database developed by DMN
  - Characterize comments by category when submitted
  - Comments are then consolidated within a category and consolidated statements are developed
  - Responses to the consolidated statements are drafted and changes made to the SGEIS if necessary
- There are 120 categories and almost 11,000 consolidated statements being processed now
- Contract with Ecology and Environment to assist with consolidating statements, responses and text drafting.

SGEIS Impact Mitigation

- SGEIS uses mix of substantive and procedural tools to address HVHF
  - Well pad siting setbacks and prohibitions
  - More detailed application requirements
  - Supplementary permit conditions
  - Thresholds for site-specific SEQRA determinations of significance

Well Pad Setbacks

HVHF is prohibited*:

- in the Syracuse or New York City watersheds or 4,000 ft buffer
- within 2000' of public drinking water intakes and reservoirs
- within 500' of primary aquifers
- within 500' of principal aquifer without site-specific review and permits
- within 100 year floodplains
- within 500 feet of private water well unless waived by owner
- On DEC managed state lands

* New to 2011 revised SGEIS

Application Process (Appendix 6)

- Well operator of proposed HVHF well must, among other things:
  - Identify source of fresh water
  - Test private water wells prior to drilling
  - Disclose chemical additives by type and volume
  - Identify measures to reduce air quality impacts (particulates and NOx)
  - Submit a fluid disposal plan for approval
  - Submit an invasive species management plan

Supplementary Permit Conditions (Appendix 10)

Permit conditions cover every aspect of drilling an HVHF well, including:

- Secondary Containment
- Reserve pit specs
- Need for ERP
- Approved blowout use preventer and testing plan
- Casing and cementing standards
  - Well design and construction requirements such as cement holding times and API specs; and
- Flowback handling and disposal conditions
- Closed loop drilling in certain instances;
- Pre-frac checklist

Related Permits and Approvals

- Approvals from Governmental Authorities other than NYSDEC
  - County, State and Local Highway Department Curb Cut Permits
  - US Army Corps of Engineers Wetland/Stream Disturbance Permit
  - Potential Need for Site Plan/Zoning Approval and/or Special Use Permit
- Consistency with SGEIS?
- Need for Draft Supplemental Environmental Impact Statement

Local Government Perspectives

- New York State Town Law and Locally Adopted Ordinances
- Protection of Public Health, Environment and Town Resources
- Towns Empowered to Adopt Local Statutes
  - Wellhead Protection
  - Noise Ordinance

Road Protection and Use

- Towns Have Clear Legal Authority to Protect Town Roads and Highway Infrastructure
- Effective Road Protection
- Adoption of Local Road Ordinances

Effective Road Protection Program

- Inter Municipal Agreements to Coordinate Use of Roads
- Engineering and Safety Assessment
- Repair Standards and Specifications
- Pre-Drilling Traffic Studies
- Comprehensive Engineering Assessment of Existing Infrastructure
- Document Condition of Roads Prior to Drilling

Effective Road Protection Program

- Establishing Weight Limits
- Restricted Roads
- Utility Crossings
- Emergency Vehicle Access
- Minimum Requirements for Road Use by Overweight/Oversized Vehicles

Solid Waste – Sludge & Contaminated Soil

Sludge or Filtrate from Treatment of Produced Water:

- Residual by-product of general WWTP or facilities specifically built for the treatment or recycling of frac fluids and produced water.
- May have higher levels of NORM material

Contaminated Soil:

- Any increased activity will likely produce more spill incidents, leading to additional contaminated soil.
- Pad liners and de-construction waste from the well sites

Solid Waste – Pads and Ponds

Liner material and cleanup waste from the demolition of water storage ponds and pad size reductions.

Solid Waste – Drill Cuttings

Drill Cuttings are fine particles of rock and shale mixed with small amounts of drilling fluids.

- Water and air are used to drill the vertical section of the well, below any fresh water zones, sometimes for the entire vertical portion of the bore.
- Most drillers switch to a synthetic oil-based mud at the beginning of the turn, through the horizontal leg.

Solid Waste – Drill Cuttings

Drill cuttings bulked at the well pad - prior to disposal.

Solid Waste – Drill Cuttings

Drill cuttings are mixed with a bulking agent at the well pad. Cement kiln dust, lime or sawdust are typically used to increase the percent solids to 50% - 60%.

Solid Waste – Drill Cuttings

Utilizing waste materials to bulking drill cuttings at the landfill will reduce truck traffic at both the landfill and well pad and conserve raw materials currently used at the pad.

Phase 1 Study – NORM in Drill Cuttings

CoPhysics CORPORATION

Phase 1 - Study to evaluate NORM in Drill Cuttings:

- Hired an expert in radiological science to evaluate and test Marcellus drill cuttings.
- Acquired Marcellus drill cutting samples directly from drill rigs at known depths.
- Gathered samples from native soils around landfill and cuttings as delivered to landfills.
- Samples confirmed by expert geologist.
- Analysis by qualified laboratory

Phase 1 Study – NORM in Drill Cuttings

LAB ID#	Sample#	Date Collected	Sample Location	Material Type	Depth (feet)	Gamma (uR/hr)	Radionuclide Concentration* ± 1 SD: Radium-226 (pCi/g)	Thorium-232 (pCi/g)	Potassium-40 (pCi/g)
Gas Drill Rig Cuttings									
738-1	31110A	3/11/2010	Bradford Co. Pa	Marcelus shale	5942	8 / 10	2.4 ± 0.2	0.5 ± 0.1	12.9 ± 1.0
738-2	31110B	3/11/2010	Bradford Co. Pa	Hamilton Limestone	6562	5 / 5**	1.1 ± 0.1	0.9 ± 0.1	17.8 ± 1.0
738-3	31110C	3/11/2010	Bradford Co. Pa	Marcelus shale	6687	11 / 8	4.3 ± 0.2	0.9 ± 0.1	15.8 ± 0.9
738-5	31910A	3/19/2010	Tioga County, Pa	Marcelus shale	6101	5 / 10	2.8 ± 0.2	0.9 ± 0.1	17.4 ± 1.0
738-6	31910B	3/19/2010	Tioga County, Pa	Marc. shale with Beyrite	6101	5 / 10	0.6 ± 0.1	0.2 ± 0.0	3.4 ± 0.2
738-13	1-M1	3/2/2010	Landfill, Lowman, NY	transported gas rig cuttings	unk	12 / 5	2.3 ± 0.1	0.7 ± 0.1	17.2 ± 1.1
738-11	2-M2	3/2/2010	Landfill, Painted Post, NY	transported gas rig cuttings	unk	12 / 8	0.9 ± 0.1	1.2 ± 0.1	16.7 ± 1.1
738-12	3-M1	3/2/2010	Landfill, Angelica, NY	transported gas rig cuttings	unk	12 / 8	2.7 ± 0.2	0.8 ± 0.1	12.6 ± 0.8
					AVERAGE ± 1 SE:		**2.1 ± 1.2**	**0.7 ± 0.3**	**14.2 ± 4.8**
Landfill Local Background Soil and Rock									
738-16	1-LS1	3/2/2010	Landfil, Lowman, NY	local soil	0 - 1	15	1.0 ± 0.1	1.5 ± 0.2	20.2 ± 1.4
738-7	1-LR1	3/2/2010	Landfil, Lowman, NY	local rock	1	17	1.0 ± 0.1	1.5 ± 0.2	16.9 ± 1.1
738-17	1-W1	3/2/2010	Landfill, Lowman, NY	local well cutting MW23	22-70	7 / 5	0.9 ± 0.1	1.6 ± 0.2	20.1 ± 1.4
738-18	1-W2	3/2/2010	Landfil, Lowman, NY	local well cutting EB04	37	7.5 / 5	0.5 ± 0.1	0.9 ± 0.1	8.2 ± 0.6
738-15	2-LS1	3/2/2010	Landfill, Painted Post, NY	local soil	0 - 1	22	1.1 ± 0.1	1.6 ± 0.2	18.2 ± 1.2
738-14	2-LR1	3/2/2010	Landfill, Painted Post, NY	local rock	8	22	0.8 ± 0.1	1.1 ± 0.1	16.4 ± 0.6
738-19	2-W1	3/2/2010	Landfil, Painted Post, NY	local well cutting MW03	10-12	6.5 / 8	0.9 ± 0.1	1.1 ± 0.1	24.4 ± 1.7
738-20	2-W2	3/2/2010	Landfil, Painted Post, NY	local well cutting MW0	28-30	6.5 / 8	1.1 ± 0.1	1.4 ± 0.1	26.1 ± 1.4
738-10	3-LS1	3/2/2010	Landfill, Angelica, NY	local soil	6	22	0.8 ± 0.1	1.0 ± 0.1	24.9 ± 1.3
738-4	3-LR1	3/2/2010	Landfill, Angelica, NY	local rock	6	22	0.8 ± 0.1	1.0 ± 0.1	30.2 ± 1.5
738-8	3-W1	3/2/2010	Landfill, Angelica, NY	local well cutting MW47A	18-20	5.5 / 8	1.0 ± 0.1	1.2 ± 0.1	29.3 ± 1.5
738-9	3-W2	3/2/2010	Landfill, Angelica, NY	local well cutting MW42A	30-32	5.5 / 8	0.8 ± 0.1	1.1 ± 0.1	23.1 ± 1.2
					AVERAGE ± 1 SE:		**0.9 ± 0.1**	**1.2 ± 0.2**	**24.1 ± 4.8**
Comparisons									
yellow brick		purchased Orange Co. NY	yellow brick (fire brick)				4.3 ± 0.5	5.4 ± 0.6	31.9 ± 3.1
red brick		purchased Orange Co. NY	red brick				1.1 ± 0.1	1.1 ± 0.1	25.8 ± 1.3
705-5		steel working factory	grinding wheel				2.3 ± 0.1	2.8 ± 0.2	n/a ±
705-9		steel working factory	800 Grit sand blast media				19.1 ± 1.0	27.2 ± 1.5	n/a ±
				EPA recommended cleanup level (40CFR192):			5 over bkg	5 over bkg	not regulated
				Typical landfil limits for NORM			5 to 50	5 to 50	not regulated

Solid Waste – NORM in Drill Cuttings

NORM – Naturally Occurring Radioactive Material

- We live with radioactivity all around us every day
- Casella hired CoPhysics to quantify the level of NORM in the drill cuttings
- 0.9 pCi/g Radium 226 – avg. concentration on-site soils
- 2.1 pCi/g Radium 226 – avg. concentration drill cuttings
- EPA standard for radium at the surface for uranium mill cleanups is 5 pCi/g for un-restricted use such as a hospital or elementary school
- Fire brick tested 4.3 pCi/g
- Sandblast media tested 19.1 pCi/g

Phase 2 Study - Ra^{226} Transport to Leachate

Barton & Loguidice, P.C.

- Casella study followed Argon National Lab protocol
- Modeled high, medium and low volumes and concentrations in materials disposed of at landfill
- Results indicate that at the high volume and high concentration (50 pCi/g), no appreciable impact to leachate or workers exist.
- Best Management Practices include:
  - 6 foot separation above leachate collection systems
  - 10 foot separation below the final cap

Potential Volume

Each well will produce 300 – 400 cubic yards of cuttings

Each well pad can have up to 16 wells

Well density is about 1 pad per square mile

Example – Tioga County New York:

519 square miles of land

Assume 50% is accessible inside the setback requirements

Potential for 1500 wells on 260 pads

300 cu.yds. X 1,500 wells = 450,000 cu yds

Considerations

Management Considerations:

- Public Relations - Static in the press and significant misinformation.
- You can be assured you will get questions – be prepared with good answers.

Disposal Facility Considerations:

- Drill cuttings are Residual waste however, can be used as an alternate daily cover.
- Drill cuttings are much more dense than compacted MSW.

Water Treatment

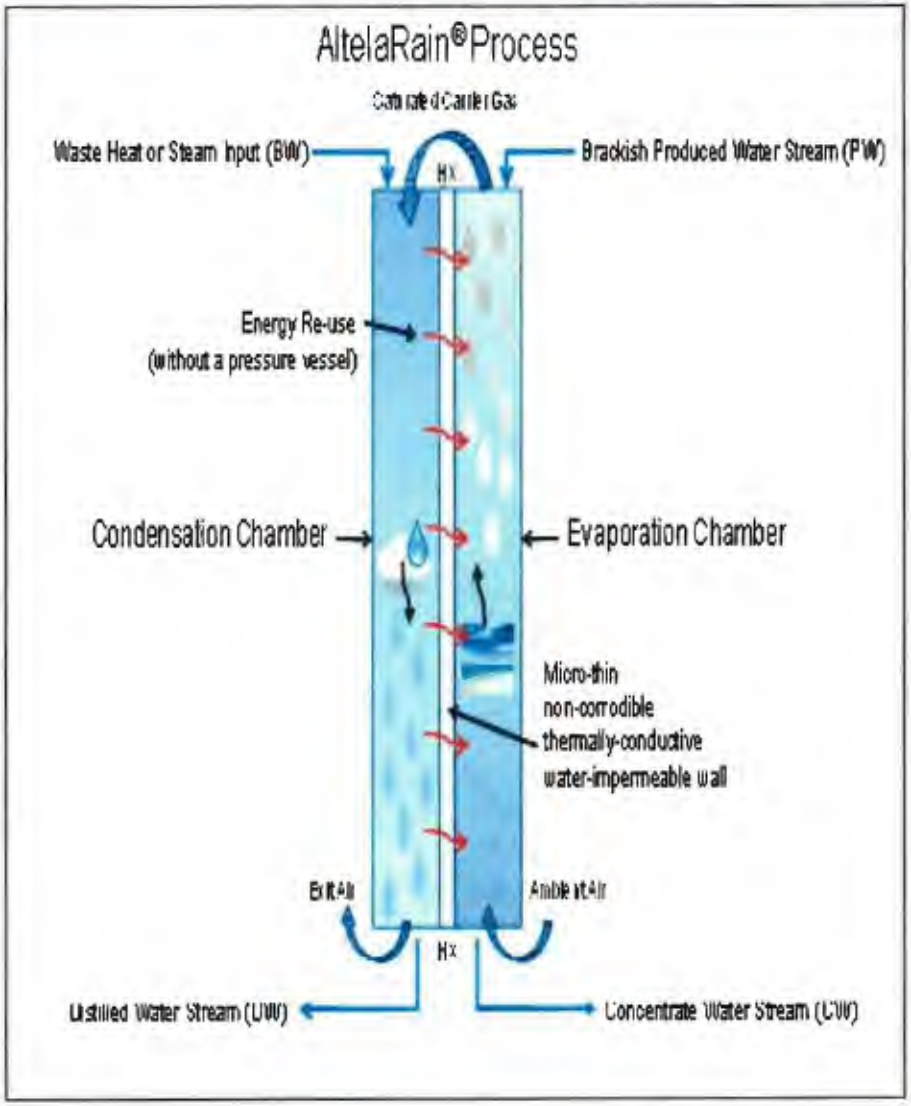
- Approximately 5M gallons of water is used to drill and frac a single well.
- The industry is currently able to recycle the majority of the frac-flowback water by combining it with fresh water to frac the next well.
- CARES provides sustainable water treatment and disposal solutions for the oil and gas industry using thermal distillation water treatment.

CARES
CASELLA & ALTELA

Water Treatment – Distillation Technology

Significant key advantages:

- Is NOT an 'evaporator'
- Extremely high quality of treated water; unique desal process removes ALL salt
- Low cost (both capital and operating cost)
- Ambient pressure operation – safe
- Near-ambient temperature operation
- High thermal efficiency
- All plastic construction
- Only desal process NOT driven by electricity
- No fouling/scaling; no membranes to replace
- Can employ low-grade waste-heat to operate, e.g., land-fill gas or compressors



Water Treatment – Precedent Setting Permits

2009 & 2010: Marcellus PA DEP Approvals: mobile & stationary AltelaRain® Systems

2009: CO General Permit issued for re-use

2008: AltelaRain® Pilot Permit in Canada

2008: Precedent-setting U.S. EPA-based approval to discharge treated, clean PW into the Colorado River Basin

2008: First-ever non-tributary water right approval for beneficial use of treated, PW in Colorado within the Colorado River Basin

2007: First-ever Navajo Nation environmental permit to surface discharge treated, purified produced water for irrigation, livestock, and agricultural re-use

2007: First-ever US EPA-based approval for a centralized produced water treatment facility for in-stream flow and aquifer recharge through a publicly owned treatment works (POTW)

2005: First-ever approval in New Mexico to surface discharge treated, purified produced water for re-use

Federal Title 40: Protection of Environment

PART 261—IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

§ 261.4 Exclusions.

(b) *Solid wastes which are not hazardous wastes.* The following solid wastes are not hazardous wastes:

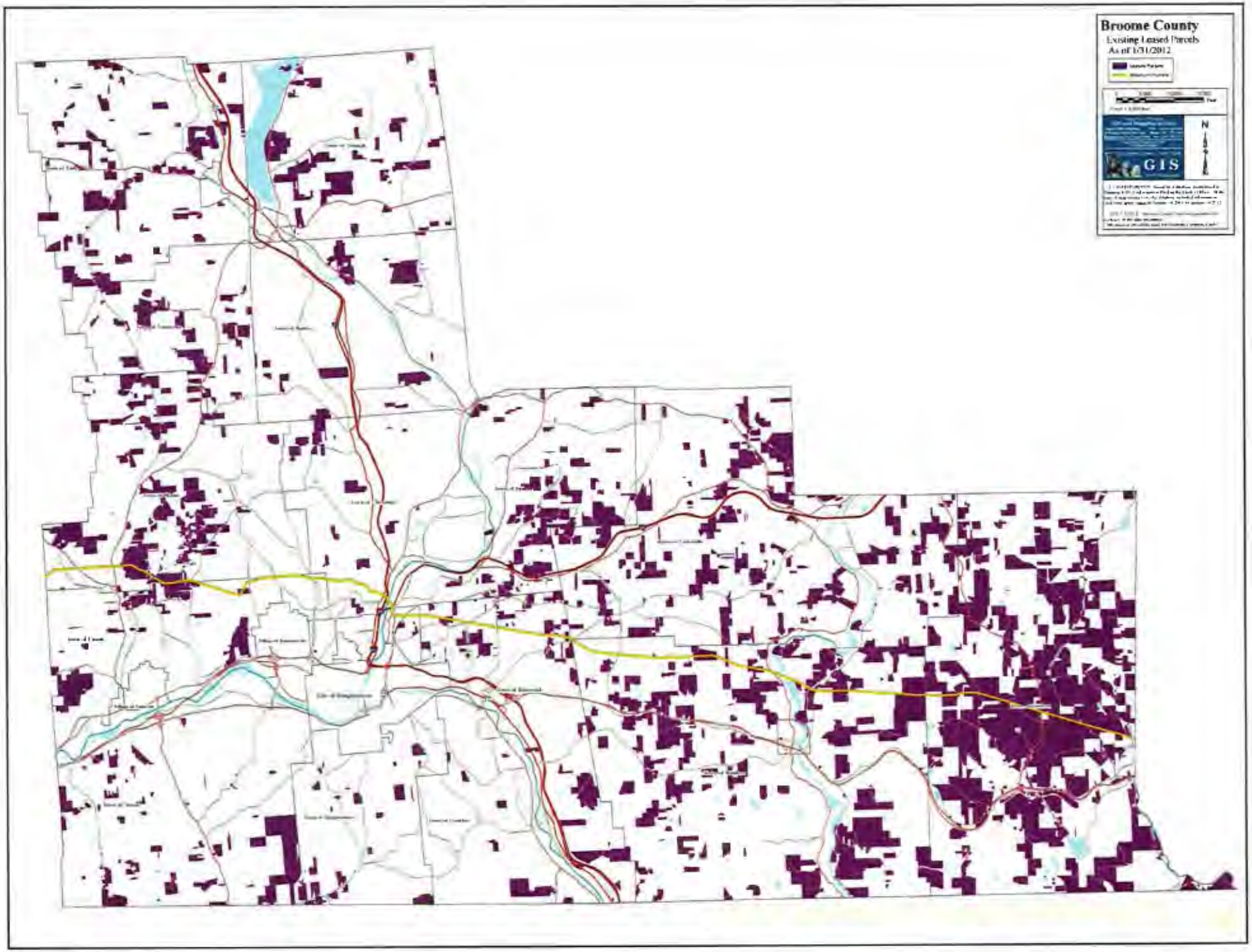
(5) Drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil, natural gas or geothermal energy.

Effective Road Protection Program

- Monitoring and Assessment
  - Identify Maintenance and Repair Needs
  - Identify Safety Issues
  - Plan/Implement Appropriate Corrective Measures
- Financial Assurances
  - Road Use Bonds
  - Cost to Maintain and Repair Structures Adversely Affected by Heavy Truck Traffic

Planning

- Town Should Plan for Drilling Well in Advance
- Start by Identifying
  - Extent and Location of Leased Land within the Town
  - Condition of Town Roads and Likely Roads Used to Support Drilling
  - Environmentally Sensitive Resources Requiring Protection
  - Sensitive Receptors and Land Uses
  - Potential for Secondary Development


Broome County
Existing Leased Parcels
As of 1/31/2012
GIS
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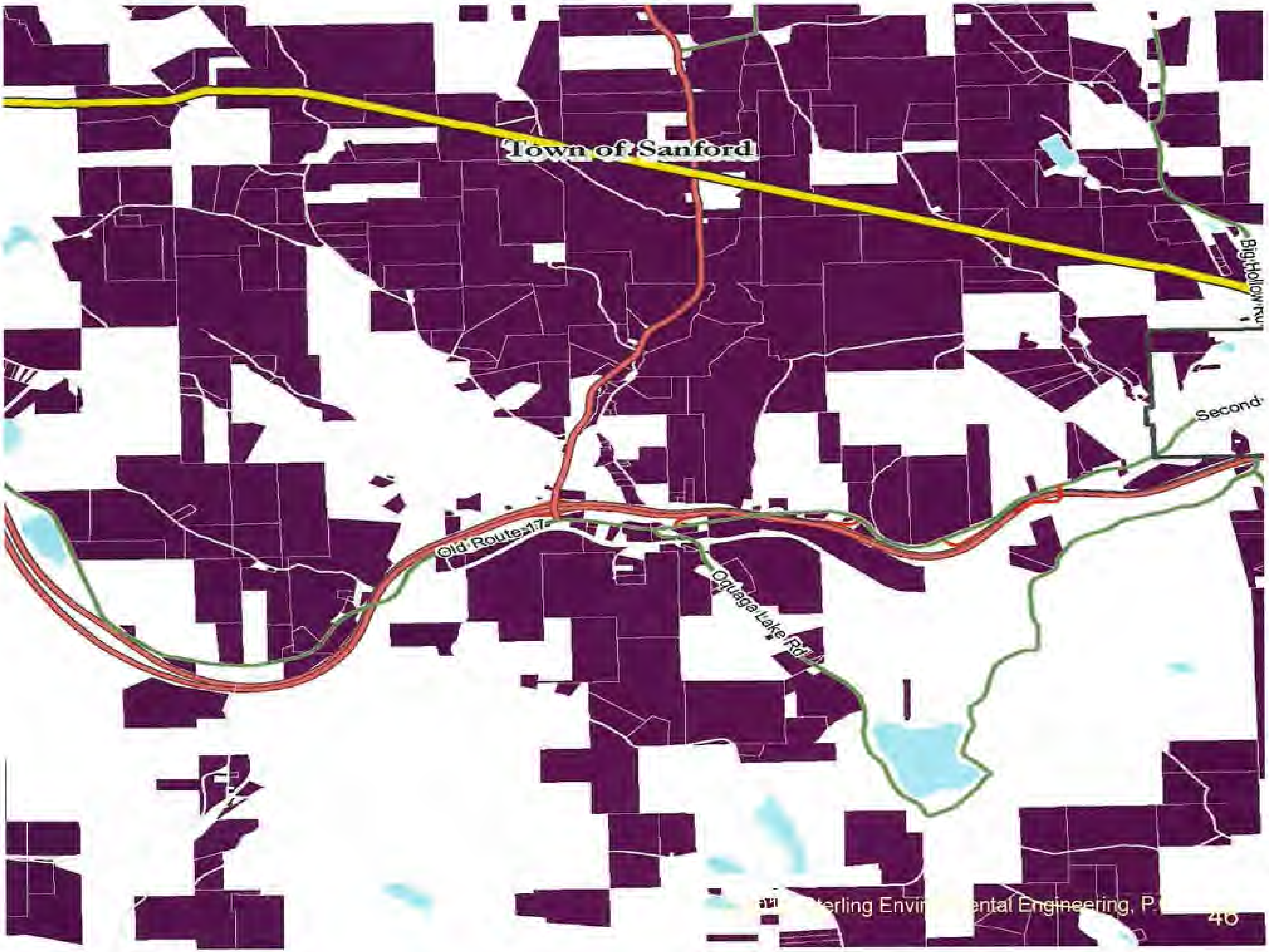
Town of Sanford
Big Hollow Rd
Second
Old Route 17
Oquaga Lake Rd

Important Considerations

- Pro and Anti Drilling Sentiment
- Residential/Commercial/Agricultural Land Use
- A Measured and Balanced Position Regarding Drilling Activities
- Assure Gas Development is Responsible and in Keeping with the Needs of the Community
- Be Very Informed and Involved with the NYSDEC Permitting Process

Questions and Answers

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