

# Water Resources Concerns

Adequate water testing



Impact of water withdrawals



Adequate wastewater treatment



Photo courtesy – Paul Hart, Hart Resource Technologies, Inc

Protection of drinking water



Risk from fracking chemicals



Regulations and enforcement



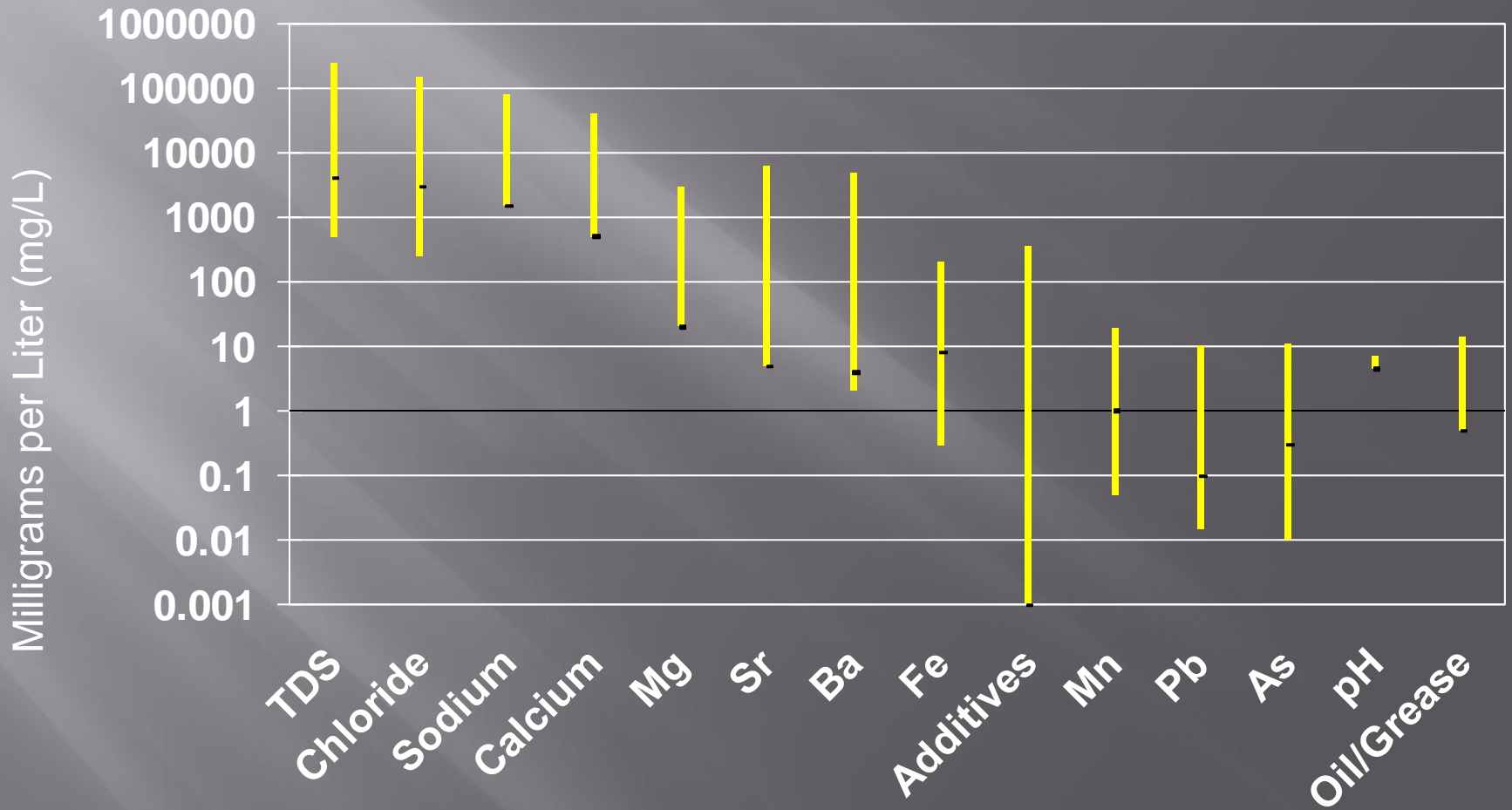
# Types of Waste Fluids

- *Top hole fluid* – freshwater encountered during drilling
- *Drilling fluids*
- *Bottom hole fluids (brine)*
- *Stimulation “flow back” fluids*  
(major source of waste fluids from Marcellus wells)
- *Production fluids*



# Wastewater Pollutants

(~20 wastewater samples)



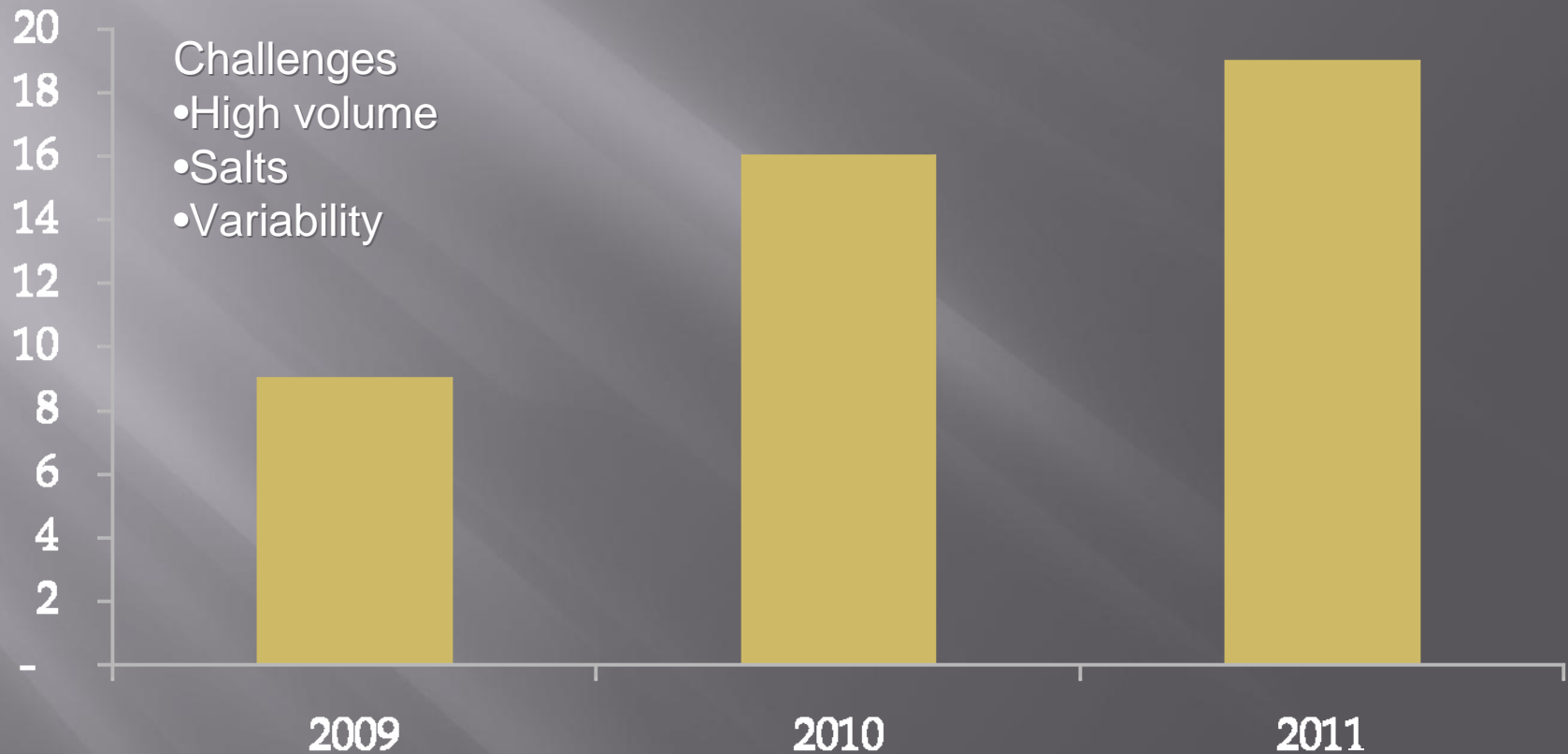
# Waste Fluid Collection and Transport

- Pit(s) with acceptable plastic liner
- Tanks
- At least two feet of freeboard in pits
- Transport to treatment via tanker trucks



# Predictions of Brine and Frac Fluids Disposal in PA

Million Gal/Day





# Traditional Wastewater Treatment

- Simple, inexpensive
- Limited capacity – Marcellus waste fluids exceed capacity
- All located in western PA
- Salt discharges – relying on dilution
- Infrastructure, permitting for new plants



# Road Application of Gas Drilling Fluids

- Only production or treated brines may be used
- DEP approval required
  - Road authorization
  - Chemical analysis of brine
  - Limited application rates and frequency (monthly)
  - Other factors - weather, location of water bodies (150'), road gradient (<10%)
- The brine generator, the transporter, the applicator and the roadway administrator



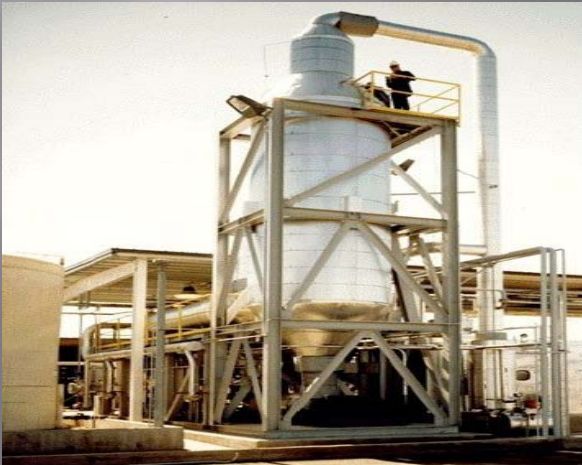
# Municipal / Industrial Treatment Plants

- ▣ Advantages
  - Readily available – many have capacity (\$)
  - Convenient locations
  
- ▣ Disadvantages
  - Inadequate processes (dilution) – may cause damage, hazardous sludge, etc.
  - May interfere with existing downstream water users
  
- ▣ Often requires permit modification, testing of 46 parameters in waste fluids
  
- ▣ Now scaled back (if permitted at all)



# Ultimate Treatment

- Evaporation
  - With or without recovery of distillate
- Membrane technologies
- Costs greatly increase over traditional treatment



250,000 mg/L of Brine



25% Salt

75% Distilled Water



Pictures courtesy of Paul Hart, Hart Resource Technologies

# Recycling / Reuse



- ▣ Portable or centralized treatment and re-use of fracturing fluids
- ▣ Typically 30-40% of frac fluids return to surface
- ▣ Initial frac flow back water can often be immediately re-used without treatment
- ▣ Remainder may be diluted and reused or pre-treated to remove metals and scale forming substances before re-use
  - Need to get TDS <50,000 mg/L
  - Hardness < 2,500 mg/L
- ▣ Area of tremendous research and development

# Proposed Effluent Standards

- ▣ After 1/1/2011, new\* sources of high TDS discharges will have to meet discharge requirements that will not impair downstream public drinking water supplies
- ▣ Treatment plants that accept gas wastewater required to have an EPA approved pre-treatment program
- ▣ Standards (in addition to current standards for pH, oil/grease, etc.):
  - TDS – 500 mg/L, sulfate – 250 mg/L, chloride – 250 mg/L, total barium – 10 mg/L, total strontium – 10 mg/L

\*New discharges are those that did not exist on April 1, 2009, and have a TDS concentration of 2,000 mg/L or a TDS loading of 100,000 pounds per day.

# DEP Final Rules for High TDS Wastewater

- ▣ Opportunities for Making Input
  - Public Comments
  - Hearings
  - Meetings and other Opportunities



- ▣ Expected Timeline for Policy Development
  - Summer 2009 thru December 2010



# Brine and Drilling/Frac Fluids Disposal in PA 2007

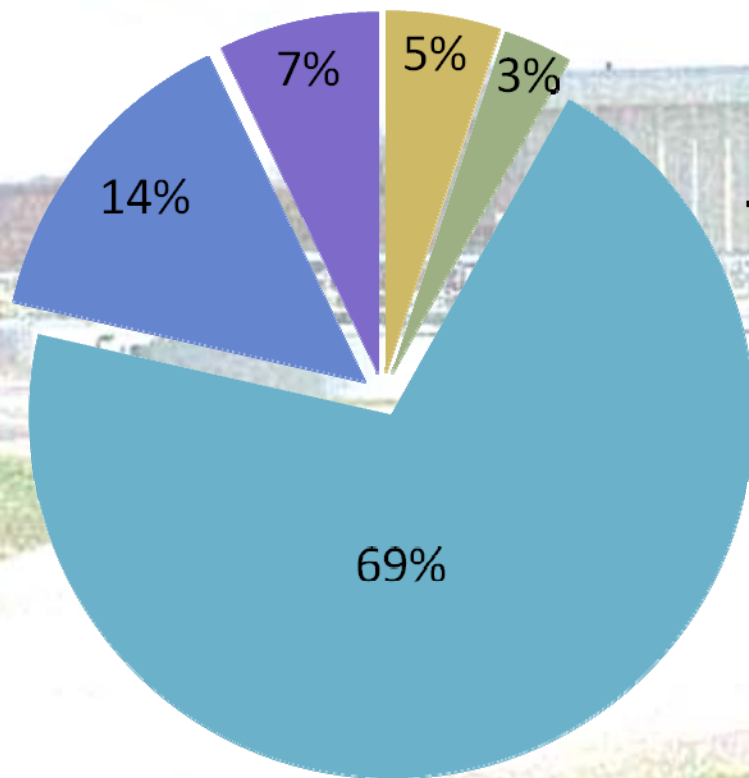
Graph courtesy of Paul Hart,  
Hart Resource Technologies

## Estimated Volumes

Brine 200,000 gallons/Day

Frac/Pit 325,000 gallons/Day

Total 525,000 gallons/Day



- Injection Wells
- Beneficial use
- Commercial Treatment Facilities
- Public Sewage Treatment Plants
- Reused/Recycled

Future - 30% conventional treatment, 25% reuse/recycle, 25% desalinization,  
10% injection wells, 10% pre-treatment to POTW

# Educational Resources Gas Drilling and Water Resources

Publications

Web sites / webinars


Presentations

PENNSTATE  
College of Agricultural Sciences • Cooperative Extension  
School of Forest Resources

Water Facts #28  
**Gas Well Drilling and Your Private Water Supply**

Gas well drilling has occurred for decades in much of western and northern Pennsylvania with tens of thousands of active gas wells in the state and over 8,000 new wells drilled each year. Most of these wells tap gas reserves a few thousand feet below the earth's surface. With discoveries of new gas reserves in the Marcellus shale and new drilling technologies to reach previously untapped gas reserves, both the number and depth of gas wells are expected to rise dramatically over the next several decades.

- Bottom hole fluids** are very old salt water deposits encountered deep underground during drilling below the fresh water aquifers. These fluids are commonly referred to as "brines".
- Stimulation fluids** are fluids that are used to improve gas recovery from the rock and are returned to the ground surface. An example is "hydrofracturing" which uses high pressure fluids to break the gas-producing rock to improve the flow of gas. Along with large amounts of water, various other materials may be used or mixed with the water for the fracturing process including sand, oils, gels, acids, alcohols and various man-made organic chemicals. The exact additives have traditionally been difficult to determine.



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natural gas exploration & drilling  
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MARCELLUS EDUCATION FACT SHEET

**Water Withdrawals for Development of Marcellus Shale Gas in Pennsylvania**

**Introduction on Pennsylvania's Water Resources**

Pennsylvania has considerable water resources both above and below ground. The state's surface water resources include more than 60,000 miles of streams and rivers, more than 4,000 lakes and reservoirs, hundreds of thousands of private ponds, and 120 miles of coastal waters, overall totaling nearly 3.5 trillion gallons of water (Figure 1). Below the surface, about thirty times more water (10 trillion gallons) is stored in groundwater aquifers along a rockface through layers of soil, sand, and rock. In an average year, Pennsylvania receives more than 40 inches of precipitation. Water is a critical component of the process of removing natural gas from underground shale rock formations. Pennsylvania's precipitation totals and surface and groundwater volumes are significantly higher than those of some southwestern and mountain states where natural gas fields are already in full-fledged gas production. The abundance of water in Pennsylvania is a double-edged sword for drilling. Water is needed for drilling, but drilling must avoid affecting the numerous water wells, streams, lakes, and other water bodies throughout the state with their operations. Although water is plentiful in Pennsylvania, a variety of user groups place significant demands on our water resources (Figure 2). The total withdrawal of ground and surface water in Pennsylvania approaches 10 billion gallons per day. In 2000 the state's largest users were thermoelectric power generators (70 percent), industrial and mining operations, including natural gas extraction (13.6 percent), do-

Figure 1. Volume of water in Pennsylvania (2000). Source: State of PA, Bureau of Hydrology of Water in Pennsylvania University Park: The Pennsylvania State University, 2000.



Figure 2. Total water withdrawals in Pennsylvania in billion gallons per day (2000). Source: Bureau of Hydrology and Education Director at Pennsylvania State University University Park: The Pennsylvania State University, 2000.



Portable Classroom DVD



- Gas drilling and your private water supply
- Water stipulations for gas leases
- Treatment options for gas waste fluids
- Gas well drilling and water resources