SAFERPA Projects

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SHALE ALLIANCE FOR ENERGY RESEARCH

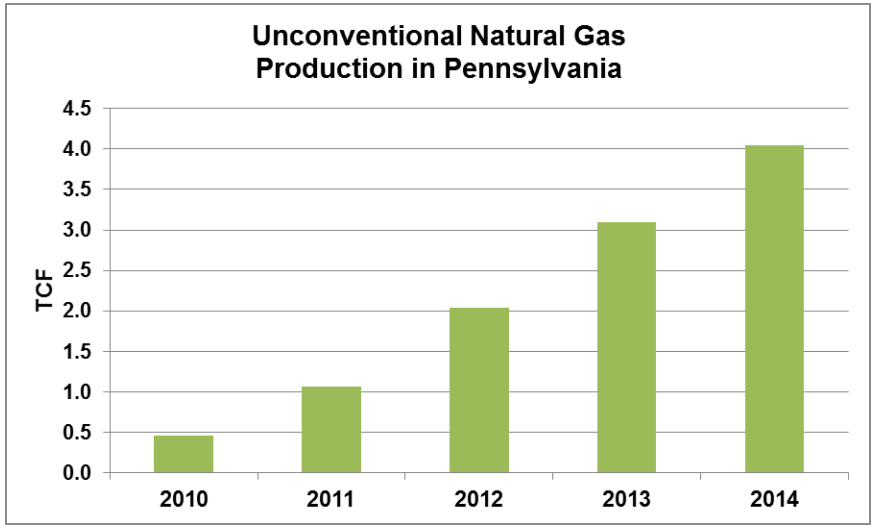
Independent science to inform good decisions…

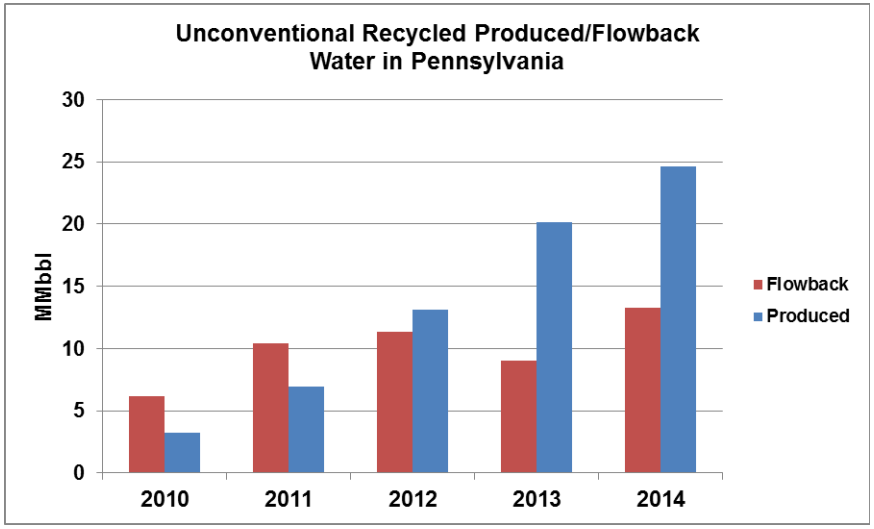
LIFE CYCLE MANAGEMENT OF FUTURE WASTE CHALLENGES FOR SHALE DEVELOPMENT IN PA

- Study of projected future trends of wastes production from shale gas resources development in Pennsylvania
- Life cycle modeling analysis conducted to assess the magnitude and the long-term implications of wastes generated during shale gas development and production operations, and identify potential options for addressing the impacts
- The primary focus of study is on the challenge of excess (non-recycled) produced water generated when shale gas is produced.
- Solid wastes comprised mostly of drill cuttings are also assessed
- Team Members: Tetra Tech, Stephen Hughes; Gas Technology Institute, Patrick Findle/Tom Hayes

Study Findings

- Production of shale gas in Pennsylvania has grown almost 300 % in the last four years and produced water generation has almost tripled in the same time frame





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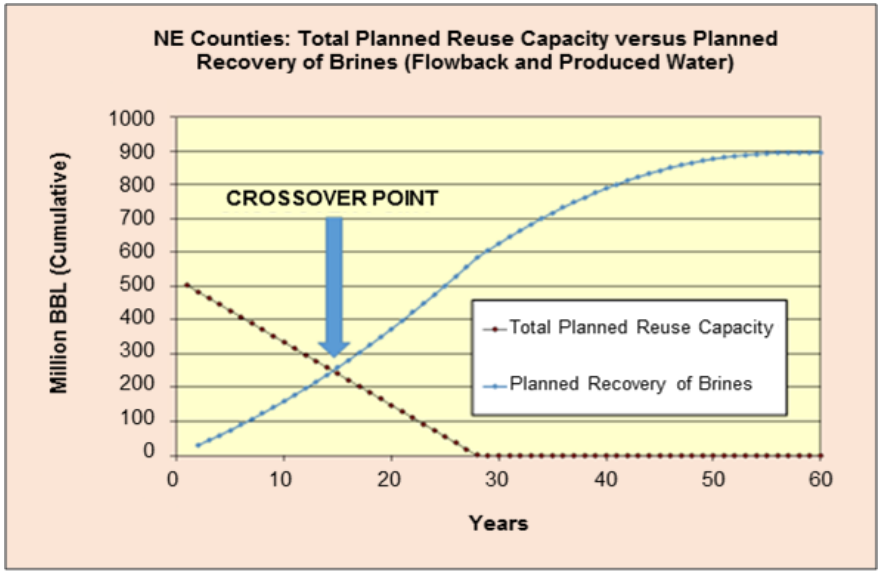
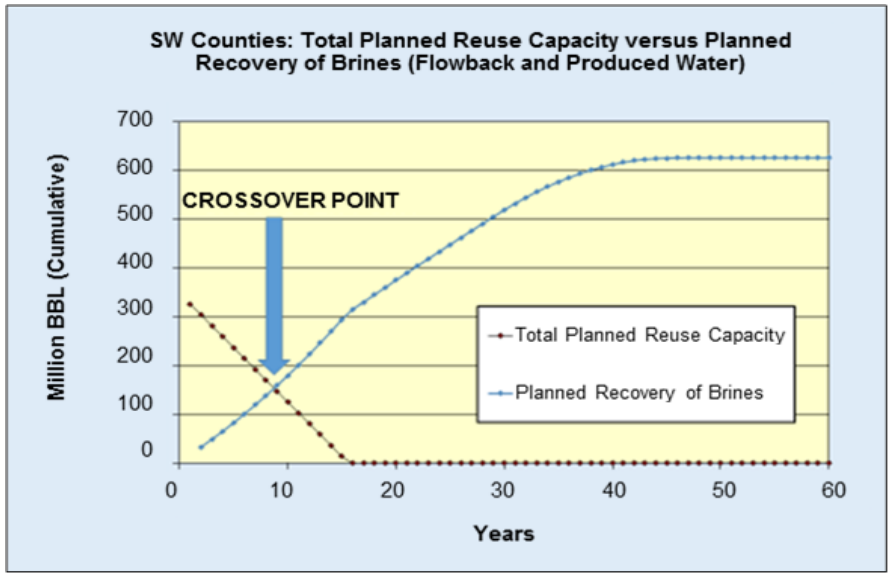
Study Findings (cont.)

- In the most productive shale gas regions in Pennsylvania (Northeast and Southwest), more than 90% of flowback and produced water is currently being recycled.
- The base model simulation identified Crossover Points where excess produced water will be consistently generated and can't be recycled.
- Potential options for dealing with non-recycled produced water include brine disposal wells and treatment plants that can generate beneficial products from the salts in the produced water

Study Findings (cont.)

- For the NE Counties (Susquehanna and Bradford) and SW Counties (Washington and Greene) the Crossover Points could occur within 14 and 9 years, respectively.





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Future Study Considerations

- Alternatives to drill cuttings disposal in landfills will be needed, along with environmentally sound beneficial reuse options.
- Additional model simulations should be considered to include regional and statewide scenarios, and other parameters such as carbon emissions, energy consumption, landfill, and road impacts.

Future Study Considerations

- It will be important to conduct more in-depth analyses to generate solutions that will be needed in the near- and medium-term including:
  - Brine disposal wells in favorable geologic formations in proximity to active shale well development areas.
  - Emerging technologies that can effectively treat produced water to a condition that allows environmentally sound surface discharge.
  - Technologies and processes that could effectively generate beneficial products from produced water.
  - Methods to characterize drill cuttings to minimize the volume disposed of in landfills and identify environmentally sound beneficial reuse options.

Technical and Logistical Feasibility Abandoned Mine Drainage Treatment and Use in Shale Treatments

- Conduct analysis and research technologies to design treatment measures to reduce the Abandoned Mine Drainage (AMD) impact on the streams of Pennsylvania, while providing a non-fresh water alternative for gas well hydraulic fracturing operations.
- Acid Mine Drainage (AMD)
  - Responsible for 5,500 miles of degraded streams in Pennsylvania
  - Commonwealth has limited budget
- Oil & Gas (O&G)
  - Typically use rivers and streams as source water
  - Encouraged to develop alternate sources
- Objective
  - Identify and evaluate methods and technologies that will be technically and economically feasible to remove sulfate from mine water to meet specifications for use in hydraulic fracturing and result in restoration of impaired streams.
- Team Members: Tetra Tech, Inc., Tom Gray; Gas Technology Institute, Patrick Findle/Tom Hayes; University of Pittsburgh, Radislav Vidic; Aquatech International Corp., Devesh Mittal

Project Scope

- Lab Testing
  - Mine water collection and characterization
  - Lab evaluation of membranes
  - Co-treatment of flowback and AMD
- Site Evaluation
  - Conceptual treatment system layout
  - Assess impact on streams
- Pilot Scale Testing
  - Nanomembranes
- Cost Estimate
- Guidance Document
- Report
  - Findings
  - Conclusions
  - Potential for Implementation
  - Recommendations

Project Schedule

- State Date: April, 2015
- Planned Completion: May, 2015
- Proposal for AMD 2 submitted to the CFA this Summer

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