

**Bryan's Swistock's Answers to Un-Answered Questions and Comments 10/28/09
Webinar**

Unanswered Questions during the "live webinar".

1. Any info as to who would be paying for these quality improvements?

Ultimately, the producer of the waste fluid is paying for treatment or disposal of the waste fluids. The gas drilling company typically pays a fee to the treatment company for treatment/disposal. The construction of new treatment plants or injection wells are usually private ventures with a variety of financial backing. The treatment company recoups the capital costs through a per gallon charge on the waste fluid.

2. The discharge from the mine was likely as a result of a breach between the deep well injection and the mine.

Some, yes, the brines from gas drilling waste were introduced into the mine water treatment system, and may have had a huge impact on the algae bloom that produced toxin and caused the 35 mile Dunkard creek fish kill?

3. Probably NY would have same limits to deep well injection??? Similar geology?

Similar to Pennsylvania, there are currently just a handful of deep injection wells in New York. There will likely be some new deep injection wells developed in New York but other treatment options will be needed to handle the majority of the wastes.

4. Are there products from the waste water that can be reclaimed and sold to help make treatment cost-effective?

The largest component of the waste fluids, by far, is salt (sodium chloride). Ideally, the salt removed from enhanced treatment processes could be used for winter ice control and other beneficial uses. However, this will require cooperation with road maintenance agencies to develop forms of the salt (particle sizes, etc.) that can be useful with existing equipment and technologies.

5. Since the waste-water contains all sorts of hazardous frac chemicals, they should never be spread on roads or injected into deep wells. The water will eventually harm the watershed and water table.

Road spreading would only occur after treatment which would remove other chemicals as part of the sludge. Road spreading is not a disposal option for untreated Marcellus waste fluids. Deep injection, on the other hand, would involve disposal of untreated waste fluids under strict permitting and well construction through the U.S. Environmental Protection Agency.

6. How will the immense amounts of water needed for RO change the flow of the stream. For a small stream like the Meshoppen, will the large amount of storm water have an effect on the overall flow of the stream.

Water withdrawals require a permit from the relevant River Basin Commission or DEP. Even if a permit is granted for a small stream, the amount of water that can be withdrawn is limited to a small percentage of the lowest (drought) flows. Other water users are also considered when granting a permit. There are also regulations dictating stormwater management at the drilling site and road network to mitigate effects.

7. Of the water remaining underground, given that the Marcellus Shale formation is, in certain areas in NYS, significantly more shallow than in PA, what mitigation strategies have been considered should these fluids migrate into primary or sole-source aquifers?

Fluids remaining underground will follow the path of least resistance. So, IF they migrate they are most likely to migrate with the emerging methane gas up the borehole and become a “production” fluid that is captured at the surface in a tank for treatment. Potential migration of fluids to nearby water wells or aquifers that feed streams is very unlikely but points out the need for landowners to conduct pre-drilling water testing to document water quality before drilling occurs.

8. Has the RO process been applied anywhere to the Marcellus gas waste stream?

I have not heard of Marcellus fluids being treated solely with the RO process. It has been used in conjunction with other treatment processes.

9. Are there any on-site treatment options available? Barnett shale had an on-site pilot test.

The simplest on-site treatment is dilution and re-use at another adjacent gas well site. There are “packaged” or portable treatment plants that can provide on-site treatment. The chemistry of Marcellus waste fluids and the volumes of fluids have been challenging for these on-site treatment systems.

10. If earthen ponds with liners are used to hold this frac water before treatment, how will we know if the liner is compromised and this is leaching into the groundwater?

There are strict requirements on the construction of collection pits but some problems have occurred. Some problems are discovered and corrected during inspections. Adjacent landowners would need to conduct pre-drilling water testing to be able to document if leaking pits had contaminated a nearby water supply. Many companies drilling in the Marcellus are using metals tanks instead of earthen pits for waste fluid collection but this is not currently required in PA.

11. There is some discussion of fracking in New York and shipping the wastewater down to PA for treatment? DO you know anything about plans for this?

Only that this had been suggested at least a short term solution for waste fluids generated in New York.

12. Are there lessons learned from the coal mining reclamation that can be used in the Marcellus operations?

Lots of lessons have been learned about proper reclamation of coal mine sites. Reclamation of gas well sites is relatively easy since the disturbance site is much smaller. The overall message is that proper attention to well construction and pit integrity will prevent problems that can, otherwise, be very expensive to clean up.

13. Can you discuss the issue of storm water used in the RO process?

Answered above

14. Of the water remaining underground, given that the Marcellus Shale formation is, in certain areas in NYS, significantly more shallow than in PA, what mitigation strategies have been considered should these fluids migrate into primary or sole-source aquifers?

Answered above.

15. Are there any on-site treatment options available? Barnett shale had an on-site pilot test.

Answered above.

16. Have you heard of "Aqua Pure" equipment? A new company wants to use this in Owego, NY.

I am not familiar with this equipment. There are dozens of companies proposing treatment of Marcellus waste fluids using a wide variety of treatment technologies and equipment.

17. Have constructed wetlands been considered for treatment of the wastewater?

Constructed wetlands are limited in their ability to remove salts, metals and other pollutants. The concentrations in untreated Marcellus fluids exceed the abilities of constructed wetlands.

18. Also, although the conventional answer to pollution has been dilution, cutting edge research now suggests some of these chemicals can have toxic impact at levels below detectable limits. How do you answer concerns over this problem?

Most of the chemicals have low toxicity but a handful are toxic at relatively low concentrations in drinking water. From the landowner perspective, this again points to the need for adequate third-party water testing before drilling to document water quality conditions. This data, in comparison to post-drilling testing can determine if any changes have occurred that warrant an investigation by DEP.

19. How will the new Ch 93 and 95 regulations affect existing facilities?

Existing high TDS discharges will be able to continue to operate under existing permit limits and conditions until such time as they propose to expand or to increase their existing daily discharge load. At that point, such a facility would have to meet the more stringent requirements.

20. Is wastewater handling under a manifest? Is there risk of mid-night dumping?

The DEP Bureau of Waste Management does track wastewater movement through a manifest system to control the risk of illegal dumping. There are various plans from citizen groups and river basin commissions to initiate continuous monitoring of many surface streams in the Marcellus region to monitor for illegal dumping or discharges of waste fluids.

21. Do you plan to do a presentation on contamination of drinking water wells - private homes?

We've done many of those presentations over the past two years throughout the Marcellus region. Currently, we plan to offer a webinar on that subject in late January 2010. More information on that webinar will be available in the near future at <http://water.cas.psu.edu>

22. How about paying for upgrades in treatment?

The majority of these treatment systems are privately owned and operated. As such, they would typically fund upgrades through fees collected for treatment of the waste fluids.

23. Is the Chapter 93 and 95 regulation change at all related to the proposed TDS requirements?

Yes – the proposed changes to Chapter 93 and 95 include new standards for total dissolved solids (TDS).

24. A number of new treatment facilities have been proposed, does anyone know where the funding comes from for new facilities?

I don't know of the specific funding sources for all of the new facilities. I have been contacted by several Wall Street investment firms looking to invest in these companies so I would assume they have extensive private backing.

Bryan Swistock's Additional Comments in "chat" or miscellaneous items:

a. What is freeboard? The distance between the surface of the waste fluids and the top of the pit. Two feet of freeboard needs to be maintained to allow for rain and runoff into the pit without the fluids escaping the pit.

b. Why is frac flowback "relatively clean"? The initial frac flowback is relatively clean because it has not been in contact with the rock formations long enough to dissolve many contaminants. As the frac process continues, the flowback that has spent longer in contact with the formation will begin to appear at the surface. This later flowback fluid is more contaminated.

c. "I still don't understand how the initial flowback water is "relatively clean" The initial flowback water is very similar to the water that is pumped into the well to fracture the formation. This is basically a mixture of freshwater, sand and the fracturing additive chemicals. It is "relatively clean" compared to the later frac return water but it certainly is NOT relatively clean compared to most drinking water.

d. Is there technology available to get the gas without fracturing the rock? Gas is held so tightly in the Marcellus formation that fracturing is necessary to get enough gas out of the formation to make the well economically worthwhile.

e. If the salt levels are so high, why is the wastewater not considered brine? ("brine" is merely a term used to refer to naturally occurring deep waste fluids. Brine wastewaters are, thus, naturally very salty because of their long contact with the formation. Frac flowback fluids that occur later in the frac process begin to look very much like natural brines because of their longer contact with the rock formations.

f. Was Dunkard Creek kill related to deep well injection? That incident is still being investigated but it appears that gas waste fluids may be indirectly responsible by providing a saline environment for the golden algae to grow which, in turn, caused the fish kill.

g. Evaporation pits in PA may need to be covered, since evaporation rarely exceeds the precipitation?

Natural evaporation is not applicable in Pennsylvania given our climate.

h. Total dissolved solids are very expensive to remove.

Extremely expensive – hence the lack of desalination plants for treating ocean water for drinking water in the United States.

i. Concentration of salts will compromise membrane

Yes, the concentration of wastes in the flowback fluids are generally very problematic for RO membranes.