What We've Learned From the West Virginia Water Crisis

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In January 2014, a chemical storage tank leaked an estimated 10,000 gallons of the industrial solvent Crude MCHM into West Virginia's Elk River. This river was the region's only drinking water source and supplied West Virginia's state capital, Charleston. Chemically contaminated tap water, with an intense black licorice odor, was then distributed to 300,000 people across a nine county area, affecting 15% of the state's population. An unprecedented Do Not Use tap water order was issued by the water company because of the tap water's unknown toxicity. Little to no toxicological data was available for many of Crude MCHM's ingredients. Only toilet flushing and firefighting were permitted. This event occurred during the first week of the legislative session, when many representatives, lobbyists, families, and their friends were in the capital.

Basic tap water activities such as showering, bathing, cooking, and baby-formula creation could not be carried out for up to 10 days. Some residents drove 60 miles to shower, others bought camping showers, used rain water, bathed in bottled water, and used plastic storage tubs for bathing their children. In the dead of winter, schools shutdown for more than three weeks. Restaurants closed. Hospitals, nursing homes, and other critical care facilities switched to emergency supplies and had water trucked in. Surgeries were postponed.

Through research collaboration, Rahul Gupta, M.D., of the local health department, and my university team estimated 90,000 people experienced acute health impacts, including rashes, nausea, vomiting, and inhalation issues. Marshall University estimated that the economic impact of this event on the state was $61 million during the first month. Plumbing system flushing was recommended in an effort to purge contaminated tap water and resulted in residents being chemically exposed to vapors emitted in their homes. Contaminated tap water, by flushing affected water infrastructure, was discharged to waterways, storm drains, septic tanks, and the sanitary sewer system. A month after the incident, it was discovered that the water plant filters were contaminated and tap water with Crude MCHM remnants was still being distributed to the population. While chemical levels found leaving the water plant were below those deemed safe by the Centers for Disease Control and Prevention, the absence of chronic toxicity data for this solvent still raises questions. The failure of storage tanks and a containment wall directly impacted public welfare and safety.

Initially unfunded, we received funding from the National Science Foundation, and West Virginia Governor Earl Ray Tomblin called on us to assist the state investigation. With Corona Environmental Consulting, we assembled an international team of experts. While the state-funded project has ended, our NSF-funded work continues today.

Having been directly involved in this incident response and recovery since January, I believe engineers within municipalities, states, and utilities should be aware of a few lessons learned.

1. **Assume the initial information is wrong.** The spill volume was revised from 2,500 gallons multiple times to ultimately 10,000. Days after residents were directed to flush their plumbing systems the company that spilled the chemical surprisingly disclosed more chemicals were present than initially reported.
2. **Use multiple laboratories for sample characterization, split samples, and archive some, too.** Sampling data is critically important. Multiple laboratories lessen the chance that the data you are relying on is wrong. This approach also helps identify when laboratories cannot do what they claim to deliver.
3. **Test for chemicals to the lowest level possible.** The public wants to know if the chemicals are gone, not "non-detect." As state of the art testing limits improve during the incident, use the lower limits.
4. **Listen to the public's questions and work to answer those questions.** The majority of those affected are not responding. They want to return to what they like doing for a living. Their questions are likely providing insight that responders may not have (e.g., inhalation exposures).
5. **Test at the exposure locations.** Your population is living the incident inside their homes. Do not only test at fire hydrants and storage tanks; few people drink or bathe at those locations. Go inside homes. Plumbing systems differ greatly from buried water distribution networks.
6. **Assume government agency advice is incomplete or wrong.** No agency took issue with flushing chemically contaminated water into resident homes. One agency claimed chemicals would not stick to plastic plumbing pipes, but referenced one of their own studies where plastic plumbing drinking water pipes were not tested. There were many more examples.
7. **Obtain data needed to make system recovery decisions by conducting rapid field and lab tests.** Conduct pilot testing in several buildings or small beakers to determine if there are any unanticipated issues with the planned actions.
8. **Ask for technical assistance from specialized individuals outside the government.** Drinking water disasters are specialized crises. People providing help should have specific experience and training, not simply an organization affiliation.

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