The Drinking Water Crisis in West Virginia, a Process Safety Failure: A Lesson for the Chemical Industry

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Introduction

West Virginia is a state located in the Appalachian region of the southern United States. It is not to be confused with the state of Virginia, from which West Virginia seceded in 1863 during the American Civil War. West Virginia is noted for its mountains and rolling hills—explaining its nickname "The Mountain State," and its logging and coal mining industries are historically significant. West Virginia is also known for a wide range of outdoor recreational opportunities, including skiing, whitewater rafting, fishing, hiking, backpacking, mountain biking, and hunting. The state has a population of 1,850,000 and its state capital is Charleston, with a population of 51,000. The legislature of West Virginia is located in Charleston. It is a part-time, bicameral legislature with a House of Delegates and a Senate. The legislature meets in regular session once each year for 60 days between January and early March.

West Virginia has several major rivers: the Ohio River along the state's western border, the Kanawha River which flows through Charleston, the Potomac River which flows along the state's northern border with Maryland, the Greenbrier River and the New River. The Elk River flows into the Kanawha River within the city limits of Charleston. This paper will explore the causes and the impact of a January 9, 2014 chemical spill into the Elk River from a chemical storage tank facility owned by Freedom Industries. The subsequent adulteration of the drinking water supply for approximately 300,000 residents in the Charleston region will be described.

Coal Mining in West Virginia

There are several major industries in West Virginia: tourism, chemical manufacturing along the Kanawha and Ohio rivers and coal mining. Coal production in 2013 totaled 117,500,000 tons with 86,100,000 tons from underground mining and 31,400,000 from above ground mining. Approximately 20,000 people are employed directly in coal mining, and another 30,000 are employed indirectly. (*West Virginia Coal Association 2013*)

Chemicals are commonly used during coal processing. When coal has been mined, coal companies use several different chemicals to clean the coal before it is sold. These chemicals separate coal from non-coal components in the mined material. One of those chemicals used is called crude methylcyclohexanemethanol ("crude MCHM"). It is a mixture with its main component being 4-methylcyclohexanemethanol (4-MCHM). Such chemical or physical washes are commonly applied to most mined materials, whether minerals or ores.

Chemical Characteristics of Crude MCHM

Crude MCHM is not a common industrial chemical, but is used in West Virginia. Before the January 9 chemical spill in West Virginia, most industrial chemists and engineers probably were not aware that it existed. One of the manufacturers of crude MCHM is Eastman Chemical Company, a major U.S. chemical company with sales of $9.3 billion in 2013. According to the Eastman Chemical Safety Data Sheet (SDS), crude MCHM is a mixture containing

- 4-methylcyclohexanemethanol (68% to 89%),
- 4-(methoxymethyl)cyclohexanemethanol (4% to 22%),
- water (4% to 10%),
- methyl 4-methylcyclohexanecarboxylate (5%)

and other components in smaller amounts. There are very little data on the physiochemical properties and health effects of crude MCHM in the SDS (*Eastman Chemical, 2011*). This proved to be a major issue in assessing the significance of contaminated drinking water reaching residential buildings and the public health impact of the spill. In addition to crude MCHM, the spilled material also contained stripped PPH, described in the Freedom Industries' SDS as polyglycol ethers. Stripped PPH was thought to be present in the crude MCHM at a concentration of 5.6%, (*WVDHSEM 2014*) but no confirmatory testing was ever conducted to validate this assumption. This information was not disclosed by Freedom Industries until January 21—approximately two weeks after the spill. The Centers for Disease Control and Prevention (CDC) reported that the spilled product contained 7.3% PPH. (*Whelton et al 2014*)

The Freedom Industries Tank Storage Facility

Freedom Industries was founded in 1992. On December 6, 2013, Freedom Industries and two affiliated companies, Etowah River Terminal and Poca Blending, were sold to Chemstream Holdings, Inc. The president of Freedom Industries remained as president until the company filed for bankruptcy on January 17, 2014. (*Federal Indictment 2014*) Freedom Industries' Charleston facility was located along the Elk River, approximately 1.5 miles (2.4 km) upstream from the river's confluence with the Kanawha River. Named the Etowah River Terminal, the facility received and stored chemicals in 14 storage tanks with a capacity of 4 million gallons. (*Freedom Industries 2013*) The facility stored chemicals, but did not conduct any chemical processing or coal cleaning.

The site included three above ground storage tanks containing the MCHM/PPH mixture and another eleven tanks containing other chemicals. It was located approximately one mile upstream from the drinking water intake for West Virginia American Water's drinking water treatment plant. West Virginia American Water is a privately owned water utility which supplies drinking water to 172,000 customers in nine counties in the Charleston area. (*WVPSC 2013*)

The Freedom Industries facility was supplied with crude MCHM by Eastman Chemical from at least the year 2000. The crude MCHM was purchased by Freedom Industries at Eastman's Kingsport, Tennessee facility. A common carrier transported the product to the Freedom Industries facility. Eastman's last sale to Freedom Industries occurred on January 4, 2014. (*Eastman Chemical 2014*)

The Chemical Spill

At 7.30 am on January 9, 2014 a resident living close to the Freedom Industries facility called the West Virginia Department of Environmental Protection (DEP) to complain about an odor that he had noticed for a few weeks but which was particularly noticeable on that morning. At 10.30 am a Freedom Industries employee discovered a chemical spill at the bottom of tank 396, which was labeled MCHM. At 11.25 am DEP inspectors arrived at the Freedom Industries facility. The person meeting the inspectors identified himself as the company president and told the DEP inspectors that there was a problem with a leaking tank.

A significant quantity of the leaked chemical breached the tank containment, including a dike wall, ran down the riverbank and discharged into the Elk River via at least two discernable, confined and discrete channels or fissures. The chemical then flowed downstream. (*Federal Indictment 2014*) It is estimated that up to 10,000 gallons of the crude MCHM/stripped PPH mixture leaked from tank 396 (*U.S. Chemical Safety Board 2014*). At 12.05 pm Freedom Industries called the state Emergency Response Spill Hotline and reported a spill of 4-methylcyclohexanemethanol (4-MCHM). (*WVDEP*)At about the same time emergency response personnel notified West Virginia American Water that there had been a spill upstream from its drinking water intake. West Virginia American Water had its sole drinking water intake about one mile downstream of the spill site. In response to the spill notification, the water company increased its use of potassium permanganate oxidant powdered activated carbon dose in an attempt to degrade and remove any organic contaminants from the water that entered its treatment facility, respectively.

By mid-afternoon the Kanawha-Charleston Health Department began receiving complaints of a strong licorice odor. At 4.00 pm West Virginia American Water indicated that its treatment plant was being overwhelmed by the contaminated incoming water from the Elk River. At 5.36 pm the West Virginia Governor (the chief executive of the state) issued a warning to citizens: **"Emergency: Do not use tap water for drinking, cooking, washing or bathing in five counties adjacent to Charleston"**. The warning was later expanded to include residents in four additional counties. At 5.54 pm the Governor declared a State of Emergency in nine counties in West Virginia, and local health departments ordered the closing of impacted facilities, including restaurants and schools. On January 10 President Barack Obama declared the incident a federal disaster, thus permitting the use of federal resources. The president's declaration allowed the Federal Emergency Management Agency to supply emergency aid, mainly bottled water, to the affected counties. On January 15 the "do not use" order was lifted for approximately half of the affected customers; the order was lifted for the entire affected area on January 18.

The chemical spill and the subsequent drinking water contamination had serious consequences for the region. Nine counties in the Kanawha Valley were impacted by the "do not use" order: Boone, Cabell, Clay, Jackson, Kanawha, Lincoln, Logan, Putnam and Roane. The population of these counties totals 480,000 and it is estimated that 300,000 residents were impacted by the state of emergency and the loss of water for all purposes except toilet flushing. Millions of gallons of bottled drinking water were distributed to the local population. People exposed to the contaminated drinking water complained of nausea, headaches and vomiting. Most at risk were pregnant women, the very young, the elderly and those with a compromised immune system. From surveys conducted by CDC and the Kanawha-Charleston Health Department it is estimated that 20% to 33% of households had at least one member experience health effects attributed to contaminated water exposure.

The impact of the spill on the reputation of West Virginia is much more difficult to quantify. West Virginians have always been proud of the state's beautiful mountains and rivers and abundant wildlife and nature. And now, it was seen as a state that could not even provide its residents with clean drinking water. There was and continues to be outrage from many residents of West Virginia. There is never a swift emotional recovery if basic needs are tampered with. And there is nothing more basic than clean water.

Known Health Effects and Consequences of Contaminated Drinking Water Exposure

At the time of the spill little was known about the health effects of low concentrations of crude MCHM or stripped PPH. There was no knowledge about safe concentrations of the chemicals in drinking water. Information in the SDSs was sparse. There were many complaints of skin irritation, nausea and headaches in the local population.

An estimation of what drinking water chemical concentrations would not adversely impact human health was a major focus of the public health response. In the affected region, drinking water was not only being used by healthy male and female adults, but also for bottle-fed infants, children, pregnant women and immune-compromised individuals. People not only ingested the water, but also used it for cooking, bathing and washing clothes. For these reasons all populations and exposure pathways were factors that should be considered when "safe" chemical exposure levels are estimated.

On January 9, within hours after the State of West Virginia asked the CDC for public health assistance, the CDC's interagency working group established a drinking water screening level for 4-MCHM of 1,000 ppb. Levels detected in the water system distribution system were found as high as 3,773 ppb according to a recent study. (*Whelton et al. 2014*) It remains unknown if this was the greatest concentration inside affected buildings because no in-home testing was carried out by the responders until one month after the incident. (*Whelton et al. 2014*) Following flushing of the West Virginia American Water distribution system, residents were directed to flush contaminated drinking water from their plumbing systems, using both hot and cold water. Twelve days after the spill, however, after some residents had flushed the contaminated water into their homes, Freedom Industries disclosed that stripped PPH was also present in the spilled liquid. In response, the CDC established two additional screening levels for the components of the Stripped PPH: one for PPH (1,200 ppb) and one for DiPPH (1,200 ppb). These chemicals were found in archived drinking water samples at levels of 10 ppb and 11 ppb, respectively. It remains unknown if more water samples contained these compounds or if their concentrations were greater when water samples were collected. No sample preservation or matrix degradation studies for these compounds were conducted. All of the CDC screening levels assumed exposure occurred by ingestion only, a 10 kg child was the most sensitive population, and exposures only occurred for up to 14 days. These levels did not consider long-term exposure.

A recent examination of in-home water testing data, the plumbing system flushing protocol issued by the water company, and medical records revealed several issues with the response. (*Whelton et al. 2014*) First, plumbing system flushing reduced chemical levels in some, but not all, homes visited by the researchers and this was likely due to equally contaminated water being drawn into buildings from the water distribution system during the flushing process. None of the homes examined by the researchers exceeded the CDC's 4-MCHM screening level, so no adverse health effects should have occurred if the screening level were set correctly. However, researchers did experience chemical exposure symptoms (i.e., eye burning, dizziness) while flushing their first plumbing system and the 4-MCHM levels were well below the CDC's screening level. These observations agree with that of West Virginia physician and emergency room medical data the researchers reviewed. Patients reported chemical exposure symptoms after being exposed to chemical vapors while flushing contaminated water out of their plumbing systems.

In March 2014, the State hired independent researchers referred to as West Virginia Testing Assessment Project (WVTAP) who established different drinking water health-based screening levels for the same compounds that the CDC evaluated. The WVTAP team was comprised of scientists and engineers from the USA, Israel, and the United Kingdom representing universities, state public health agencies, a nonprofit organization, and private companies. WVTAP toxicologists determined "safe" drinking water screening levels of 120 ppb (4-MCHM), 850 ppb (PPH), and 250 ppb (DiPPH) and based these determinations on different assumptions than the CDC. WVTAP assumed the most sensitive population was the formula-fed infant, a 28-day exposure period, and inhalation, dermal, and ingestion exposure routes. (*TERA 2014*) Both the WVTAP team and the CDC acknowledged that the available toxicological data were not voluminous and there were no studies that examined vapor exposure to animals. Like the CDC levels, the WVTAP levels did not consider long-term exposure.

There were several other important research discoveries following the spill, and there are several ongoing studies that pertain to the environmental and human health impacts of this spill. First, WVTAP discovered that the water company filters remained contaminated 2.5 months after the spill and the population had likely been exposed to low levels of 4-MCHM during this time. (*Rosen et al. 2014)* Second, university researchers have reported that crude MCHM obtained from Eastman Chemical Company in 2014 was twice as toxic for an aquatic organism, *Daphnia magna*, than when Eastman Chemical Company last tested the product in 1998. (*Whelton 2014*) Reasons for this difference are currently unclear and are being investigated. While *D. magna* toxicity data are not used for human health risk assessments, the findings implied that some of the limited toxicity data available may not be representative of the spilled product.

At the request of West Virginia's federal congressional leaders and the Governor, the Department of Health and Human Services National Toxicology Program began conducting several follow-up studies: (1) computer modeling to predict potential adverse effects from the chemicals, (2) a variety of toxicological models to look at potential developmental outcomes in animals, and (3) short-term exposure to measure subtle biological changes in animals. (*NTP 2014*) These studies will provide useful information, but none involve direct animal inhalation exposures. Shortly after the spill, the CDC concluded it could not establish an inhalation screening level due to the lack of data, but nine months later, the U.S. Environmental Protection Agency established an inhalation screening level for 4-MCHM using the same toxicological data that the CDC had available. It remains unknown if adverse health impacts would occur at the EPA's established 4-MCHM air concentration. While other chemicals were present in the contaminated drinking water, an air screening level was only established for 4-MCHM. *(EPA 2014)* Several university researchers and government agencies in the U.S. are currently conducting toxicological studies to better understand the short- and long-term human health impacts of this chemical exposure. Additional studies continue pertaining to chemical fate in plumbing systems, the water treatment facility, distribution system, sewer system, and the environment.

Investigations

There were many investigations into the chemical spill, some of which have been completed and some of which are continuing. Among the state and federal agencies performing investigations are the U.S. Chemical Safety Board (CSB), the National Toxicology Program of the National Institute of Environmental Health Sciences, the CDC, the West Virginia Department of Health and Human Services, the U.S. Environmental Protection Agency, the Kanawha-Charleston Health Department, the DEP and the West Virginia Public Service Commission. As noted above the State of West Virginia also commissioned an independent team of researchers to lead the WVTAP effort. Outside government-sanctioned investigations, university researchers, some teaming up with local grassroots nonprofit organizations, have and continue to conduct their own investigations.

The United States Chemical Safety Board Investigation

The CSB is an independent federal agency charged with investigating industrial chemical accidents. Headquartered in Washington, DC, the agency's board members are appointed by the President and confirmed by the U.S. Senate. Congress designed the CSB to be non-regulatory and independent of other agencies so that its investigations might, where appropriate, review the effectiveness of regulations and the regulatory enforcement. (*U.S. Chemical Safety Board*, 2014) The CSB's investigation started shortly after the spill was discovered, and a team of five investigators arrived on the scene on January 13.The CSB had previously conducted two major investigations of chemical plant incidents in the Kanawha Valley: in 2008 at a Bayer CropScience facility and in 2010 at a DuPont chemical plant. As a result of those two investigations the CSB is well known in the area and it has a solid reputation there for independent investigations.

A significant focus of the CSB's investigation was to examine the condition of 48,000 gallon storage tank 396 which contained the MCHM/PPH mixture. In an update given on July 16, 2014, the CSB stated that it had "found no record of a formal industry approved inspection performed on any of the chemical storage tanks". In tank 396 the CSB found that "two small holes ranging in size from 0.4 inch to 0.75 inch were caused by corrosion, likely resulting from water leaking from holes in the roof and settling on the tank's floor". The CSB is examining other aspects of the spill, including the regulatory framework covering aboveground storage tanks. The CSB's investigation is expected to be completed by the end of the first quarter of 2015.

Product Stewardship of Crude MCHM

The American Chemistry Council (ACC) is a trade organization located in Washington, DC representing the leading companies in the chemical industry. ACC members have to make a voluntary commitment to uphold the highest standards for protecting health, safety, and the environment. ACC is committed to improved environmental, health and safety performance through the Responsible Care® initiative. Responsible Care® is a condition of membership for ACC members, and Responsible Care® Partner companies have all made CEO-level commitments to uphold the program elements. The Responsible Care Guiding Principles are at the heart of the Responsible Care commitment—through these principles, members and Partners pledge to improve Environmental, Health, Safety and Security performance for facilities, processes and products throughout the entire operating system. There are three Responsible Care Codes of Practice: Product Safety Code, Process Safety Code and the Security Code. Within the Product Safety Code there are eleven Management Practices. Practice number 9 is value chain communication, cooperation and outreach and it states in part "*Processes are in place to communicate, receive and evaluate product safety and stewardship information and requests from value chain participants. If improper practices involving a product are discovered, corrective measures are taken based upon a company's independent judgment, ranging from resolving the improper practices to termination of business relationships, if necessary."* (*ACC 2014*) In an e-mail to the corresponding author Eastman pointed out that "ACC provided a phased implementation for the Code's 11 management practices. The first three management practices of (1) Leadership Commitment, (2) Accountability and management, and (3) Prioritization of products were scheduled for implementation on December 31, 2014". Implementation of Management Practice 9 is scheduled for December 31, 2016 *(Eastman Chemical 2015)*

After the spill Eastman Chemical provided information on its web site on February 27, 2014 in a document titled "Questions and Answers Regarding Eastman's Assistance in the Emergency Response to the Spill of Crude MCHM in Charleston, West Virginia**".** (*Eastman Chemical 2014*)

Storage Tank Regulation Before the Freedom Industries Spill

Before the Freedom Industries leak, underground storage tanks were directly regulated in West Virginia, but aboveground storage tanks were not—unless the site was otherwise regulated under the Clean Water Act. Because the Freedom Industries site was an aboveground storage tank farm, the only regulations and permits with relevance to its tanks stemmed from the Clean Water Act.

Underground Storage Tanks

In 1984, Subtitle I was added to the federal Solid Waste Disposal Act, which created a nationwide program to regulate underground storage tanks that contain petroleum or hazardous chemicals. The goal of the program was to limit corrosion and structural defects and minimize future tank leaks. The West Virginia Legislature enacted the Underground Storage Tank Act (W.Va. Code §22-17) and its associated regulations to allow the DEP to assume regulatory primacy over the state's Underground Storage Tank Program. Through this program, DEP oversees tank installations, upgrades, and closures; certifies underground storage tank workers; distributes operations and maintenance manuals; ensures that owners or operators demonstrate financial responsibility; collects registration fees; and maintains a database of underground storage tanks. The agency issues certificates to facilities that have paid their fees, and, importantly, prohibits deliveries to underground storage tanks for which owners or operators have not met certain obligations. In addition, the Leaking Underground Storage Tank Program provides funding and procedures for addressing polluting sites.

Aboveground Storage Tanks

While West Virginia had not enacted any direct regulations of aboveground storage tanks before the leak, two major federal Clean Water Act regulations applied to many aboveground storage tank sites, including the Freedom Industries site.

First, the federal Spill Prevention, Control, and Countermeasure (SPCC) rule (Title 40, Code of Federal Regulations, Part 112) applies to facilities with an aggregate aboveground oil storage capacity greater than 1,320 U.S. gallons. This rule defines "oil" very broadly. The SPCC rule applied to the Freedom site because mineral oil, fatty acids, and diesel fuel were stored in sufficient quantities at the site. (*Federal Indictment, 2014*)

Sites covered under the SPCC rule must undertake a range of activities to prevent spills, including using containers suitable for the substance that is stored, providing overfill protection, installing and maintaining proper secondary containment, and inspecting the site. In addition, covered sites must prepare SPCC plans that document operating procedures, control measures, and countermeasures to contain, clean up, and mitigate the effects of spills. In addition, spills must be reported to the National Response Center in Washington, DC.

The second existing regulation that applied to many aboveground storage tank sites in West Virginia is the West Virginia/National Pollutant Discharge Elimination System (WV/NPDES), which provides for permits to allow the discharge of pollutants from point sources. Many sites with aboveground storage tanks are covered under the WV/NPDES general multi-sector industrial stormwater permit (WV0111457). The Freedom Industries site was registered under this general permit, with registration number WVG610920, which was issued to Etowah River Terminal, LLC on November 17, 2009.

This general permit is designed for establishments with discharges composed entirely of stormwater associated with industrial activity. It is largely based on the prevention or reduction of pollutant discharges through the implementation of best management practices. In order to register under the general permit, DEP must approve two key documents submitted by the permittee: a stormwater pollution prevention plan (SWPPP) and a groundwater protection plan (GPP). These plans then become enforceable aspects of the permit. The SWPPP and GPP provide details on the practices that the permittee will implement to ensure that discharges from the site limit potentially harmful discharges to the environment. Freedom Industries did not develop or implement either of these plans. (*Federal Indictment, 2014*)

Like the SPCC plan, the SWPPP should have included a number of components that would have minimized the risk of a leak, and which would have prepared for the proper response to a leak should it occur. For example, it should have identified onsite risks and provided an inventory of the types of materials handled. It should have considered factors when evaluating the pollution potential of runoff such as the toxicity and quantities of chemicals and the uses of the receiving waters. It should have included spill prevention and response procedures, which identify areas where potential spills can occur and their accompanying drainage points. It should have specified procedures for cleaning up spills and made this information available to the appropriate personnel, along with the necessary equipment to implement a cleanup. Employees should have been trained in spill response, good housekeeping, and material management practices. Also, qualified company personnel were to have conducted inspections and kept records of such inspections.

In short, while the SPCC and WV/NPDES regulations apply to many sites with aboveground storage tanks, they only apply to sites that store a certain amount of oil (SPCC); that qualify for the WV/NPDES general multi-sector industrial stormwater permit, or that require individual WV/NPDES permits. The failure of these regulations to prevent the leak at the Freedom Industries site points to ineffective oversight by DEP which administers both programs in West Virginia. The fact that these regulations do not apply to all sites with aboveground storage tanks led the Legislature to enact new, broader requirements following the Freedom Industries leak.

The Legislative Response to the Spill

The West Virginia legislature meets in regular session for 60 days each year in Charleston. In 2014 the legislative session opened on January 8 and it was in session on January 9 when the drinking water contamination occurred. Many of the members of the House of Delegates and the Senate were staying in local hotels or apartments and were directly impacted by the "do not use" order. They could not shower or drink the water. They had to rely on bottled water and non-contaminated facilities for washing and showering. One state delegate developed a serious eye infection, apparently as a result of exposure to the contaminated water, and had to be hospitalized. This surely had an impact on the legislators' response to the crisis. Senate Bill 373 was unanimously passed by the Legislature on March 8 - the final night

of the 2014 regular session—and was signed into law by Governor Earl Ray Tomblin on April 1. It included numerous provisions to help prevent contamination of drinking water and to better plan for responses should contamination occur. Among these provisions was the Aboveground Storage Tank Act (AST Act), which created an entirely new section of state code (W.Va. Code §22-30).

During the debate in the Legislature, it became apparent that regulators had no clear idea of the number of aboveground storage tanks in West Virginia. The AST Act therefore required an inventory of all aboveground storage tanks to be completed by October 1, 2014. Approximately 47,000 aboveground storage tanks were registered by the end of 2104.

The AST Act also required the submission of initial Spill Prevention Response Plans (SPRPs) by December 3, 2014 and initial inspections and certifications by January 1, 2015. The specific requirements for these initial actions were later clarified in an interpretive rule, with a November 20, 2014 effective date (W.Va. Code of State Rules §47-62).

Overall, the AST Act established a new aboveground storage tank regulatory program that includes, among other things, permits, performance standards, leak detection systems, recordkeeping requirements, corrective action requirements, and financial assurances. The Legislature directed the DEP to develop specific requirements via an emergency rule. The agency sought feedback at multiple stages during the rulemaking process, and released a final rule for public comment on December 22, 2014. After the comment period ends on January 21, 2015, the rule will go to the Legislature during the 2015 session for final approval.

The AST Act applies to all ASTs that hold 1,320 or more gallons of almost any substance in a single vessel (as opposed to the SPCC rule, which applies to facilities that store 1,320 or more gallons of oil, in aggregate). While the Act itself applied the same standards to every tank, the November interpretive rule and the draft emergency rule divide tanks into three levels based on location, contents, and volume. Level 1 tanks - which are located near public surface water intakes, are large, and/or hold certain hazardous substances—have the most stringent requirements. Requirements for Level 2 and Level 3 tanks, in turn, are less burdensome. Another section of Senate Bill 373 requires DEP to compile an inventory of potential sources of significant contamination located within zones of critical concern for public water systems whose source of supply is obtained from a surface water supply source. Public water systems are also required to submit source water protection plans to the Bureau of Public Health by July 1, 2016.

The effectiveness of West Virginia's AST Act will not be known until it is clear what actions the Legislature takes during the 2015 session on the emergency rule and on the Act itself. Only then will DEP start collecting fees and start actively implementing its new rules and powers.

Legal Aftermath of the Chemical Spill

- Freedom Industries was permitted to declare bankruptcy on January 17, 2014
- On December 8, 2014, the president of Freedom Industries was charged with bankruptcy fraud, lying and committing wire fraud by filing false documents in the ongoing Freedom Industry bankruptcy proceeding.
- On December 17, 2014 federal prosecutors charged Freedom Industries and six of its owners, managers and employees (including the president) with criminal violations of the federal Clean Water Act. Four owners were charged with failing to meet a "reasonable standard of care" in running the company. Two former employees, the plant manager and the environmental compliance officer were charged with one violation of the Clean Water Act.
- Several civil lawsuits have been filed by local citizens against Freedom Industries and Eastman Chemical. (*Legal Newsline 2014)*

Lessons Learned from the Spill and its Aftermath

For the Chemical Industry

- Facilities with storage tanks containing hazardous materials should have programs in place to regularly evaluate the mechanical integrity of the tanks and secondary containment.
- Chemical plants should be aware of drinking water facilities downstream from their operations and should be in regular communication with them.
- It should be a priority for facilities to prevent chemical spills into streams or rivers which are drinking water sources.
- Chemical manufacturing companies should be aware of the environmental status of their customers' operations. If they are not satisfied with a customer's operations they should enter into a discussion with the customer with the objective of improving the customer's operations or discontinuing their relationship with the customer.
- When spills occur companies should provide the responders with all available chemical composition and analytical product characterization information as soon as possible. Responders may seek assistance in developing analytical methods for detecting the chemical product's compound in environmental matrices air, water, and soil. Information provided by the companies to

responders will be used to make decisions to protect the health of the people affected and understand the magnitude of the water contamination event.

For Drinking Water Suppliers

- Drinking water providers should create management plans with public input, in which they identify potential significant contaminant sources upstream from their intakes and take steps to minimize the risk of contamination from these sources. Ultimately however, any identification of contamination threats should be considered sensitive information. While management plans should include efforts to prevent potential significant contaminant sources from being sited in particularly sensitive areas, such as alongside rivers directly upstream from intakes, policy actions should be sought by drinking water suppliers to prevent these threats from being installed.
- The characteristics of the materials upstream from drinking water intakes should be made available to drinking water providers. Chemical, physiochemical properties (at different temperatures), odor characteristics, and toxicity should also be made available. This information is critical to predicting the fate of compounds in the water treatment facility, distribution system, and building plumbing systems.
- Because source water contamination threats and incidents will occur, adequate storage and/or alternate water sources should be available so that the community can still receive water for basic activities if their source water becomes temporarily contaminated. West Virginia American Water had only a three-hour supply of water when it learned about the spill. Other nearby water sources should be considered (e.g. lakes, rivers, oceans) to mitigate the loss of a water utility's only source water. Interconnections to neighboring water supplies could also be another action. Increased treated water storage capacity is another measure that would enable water utilities to get through at least one, but possibly more days of water production outage from the acutely contaminated source. Storage and alternate sources must be available.
- Tabletop and/or field training exercises should be carried out for large-scale drinking water contamination events. These exercises should be based on scientific principles with realistic scenarios. Decontamination of utility infrastructure as well as plumbing systems should be a major focus of the event. After these exercises the existing water system emergency response plan should be revised.

For Emergency Responders

- Immediately obtain the spilled liquid from the site and send it to laboratories to be fully characterized. Do not overly rely on the organization responsible for the spill to provide information that responders will use to protect the community. The faster responders know what chemicals were in the spilled product, the faster they can pinpoint these compounds (and their degradation products) in the drinking water system and public health officials can establish "safe" exposure levels.
- Before a spill occurs, identify which organization is responsible for the required environmental sampling that is needed and confirm with them they understand this responsibility. It is likely that organizations responding to a spill into a drinking water supply may not understand their role. The following sampling procedure is a must following a chemical spill that affects a drinking water supply: (1) at the spill site in the water affected, (2) at the water treatment plant (at the intake, inside the plant, and as water leaves the plant), and (3) at predesignated buildings in the affected area. The goal of the sampling should be to characterize the water's composition, the location of the contaminated water, the severity of the contamination, and chemical exposures the residents have or may experience. The spilled chemicals water may move downstream and/or partially settle in the water column. Air, water, and soil sampling may be required.

For Public Health Agencies

- Health officials should be flexible in revisiting health-based chemical exposure levels as new spill response data comes available. West Virginians were exposed to low levels of chemicals for 2.5 months after the spill, and the health implications of long-term chemical exposure remain unknown. The CDC's drinking water exposure limit only considered a 14-day exposure period.
- To avoid human health impacts caused by plumbing system flushing, health officials should conduct a building trial flush and monitor indoor air contamination, especially when contaminated water contains volatile chemicals. If health impacts are detected after flushing is authorized in the affected area, officials should consider intervening and revise the procedure. When critical toxicity data are lacking, public health agencies should rapidly authorize the conduct of necessary experiments to fill those gaps.
- Any drinking water chemical level established as "safe" should apply to all routes of drinking water exposure: ingestion, inhalation, and dermal. This "safe" level must consider dermal and inhalation exposures inside affected buildings at conditions typical of water use (i.e., hot water, steam/vapors).

For Political Leaders

- Political leaders should not be restricted in who they receive scientific expertise from in the aftermath of a spill. In West Virginia, the necessary expertise needed to respond, investigate, and recover from the spill did not all reside with the water company or with local, state or federal governments. Scientists from elsewhere in the U.S., Israel, and the United Kingdom were called in to

provide assistance. Additionally, scientists and engineers who were not called in but volunteered, teamed up with local grassroots organizations, and received funding from government agencies not involved in the response were able to provide critical insights.

- Leaders should listen to the concerns of the community and take action to find answers. Questions from the affected population can provide valuable insights that responders might not be aware of, especially if the only water testing is being conducted at fire hydrants, not inside homes where the population lives. Leaders can facilitate the dedication of resources from government agencies that may or may not already be involved in the response.

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