Case Study: Manson, Iowa, Responds to Tornado

Consider these problems: service and line breaks, a loss of system pressure, more than 100 yd^3 (76 m^3) of debris strewn over the cover of the ground storage reservoir, and suspected back siphonage. No water supply would want to be faced with these problems, yet the town Manson, Iowa, struck by a tornado on June 29, 1979, had to come to terms with these dilemmas

Some of the damaged or destroyed facilities held stocks of pesticides, and damaged pesticide containers were scattered throughout the city. The tornado also had downed electrical transformers and it was feared that coolant leaking from the transformers could be seeping into the water supply, adding the possible threat of polychlorinated biphenyls (PCB) contamination to an already critical situation. Further investigation revealed that the transformer coolant was a highly refined petroleum product rather than the suspected PCB. Tests also showed that there was no organic pesticide contamination present.

Membrane-filter tests did show, however, that the water was contaminated with bacteria. Because the water supply had no disinfection treatment, system personnel had to devise a way to introduce chlorine into the system. The first chlorination effort involved dissolving 200 lb (91 kg) of 70 percent available chlorine granules to form a saturated solution in 30-gal (113-L) garbage cans, and emptying them manually into the reservoir. This proved to be a difficult and slow process.

The final solution to the chlorination dilemma was characteristic of the ingenuity and resourcefulness that often result from a critical situation. The water supplier called on the city fire department for the use of 500-gal (1900-L) capacity pumper unit as a makeshift chlorinator. Initially, one half of a barrel (50 lb [23 kg]) of chlorine granules were added to the pumper and mixed by on-board agitation. Because the National Guard was supplying the town with an emergency potable water supply and requested that residents curtail their water usage, a longer contact time was allowed for the high-strength chlorine solution being drawn into the distribution system An additional 600 lb (273 kg) of chlorine granules were subsequently introduced into the system with the aid of the pumper. Complete potable water service was restored to the residents within one week of the tornado. In order to prevent a future emergency makeshift operation, a hypochlorinator was installed July 2, 1979.

Source Journal AWWA, *April 1980.*

Floods

Few areas of North America can be considered safe from flooding. The US Army Corps of Engineers estimates annual flood damage in the United States to cost hundreds of millions of dollars. Flooding can be caused by heavy rainfall (Figure 2-6) or snowmelt, hurricane storm surges, high tides, volcanic eruptions, or dam breaks.

A flood can contaminate water supplies, inundate transmission and treatment facilities and pumping stations, scatter and ruin stockpiled equipment, and disrupt power, transportation, and communications. Floods from precipitation are relatively easy to predict and defend against, provided sufficient funds are made available at the national and regional level to take preventive measures. Floods can also be unexpected and unpredictable as with a dam break, breaching of the underground tunnels (which recently occurred in Chicago), or unusually severe rainfall. For example, the Des Moines, Iowa, water treatment plant was flooded and taken out of service during the summer of 1993 when the Raccoon River overflowed its banks. Flood elevations at the Des Moines plant were about 8 ft (2.5 m) above the 100-year flood elevation. Water service to 250,000 people was cut off for several days

Forest or Brush Fires and Firestorms

A forest or brush fire can damage watersheds, water system structures, and strain water supplies if used for fighting the fire. Forest and brush fires can happen

Source: *D.K. Sander.*

Figure 2-6 Flooding in Washington State

anywhere, and particularly occur in areas affected by dry weather or drought. Firestorms in urban or suburban areas, such as the one in Oakland, Calif., in 1991, are increasing in frequency.

Volcanic Eruptions

The Pacific Northwest, Alaska, Hawaii, and central Mexico are areas particularly prone to volcanic eruptions. The most dramatic recent example of a volcanic eruption occurred at Mount St. Helens in Washington State in 1980. More than 80 people died, and damage was widespread. The predictability of volcanic eruptions has become more refined in recent years although volcanoes can erupt without warning. Residents near Mount St. Helens were given several days warning that an eruption was imminent.

The hazards from eruptions include explosive winds, fire, falling rock, lava flow, floods due to mud and snowmelt, and ash. These hazards can damage structures and equipment, foul water supplies, choke intake structures, and contaminate watersheds.

Other Severe Weather

Severe weather, such as extreme cold or heat, heavy snows or ice storms, or high winds, can have both short- and long-term impacts on a system. Deep snows can prevent water utility personnel from reaching their stations. The snow can cover the locations of valves and other components. Lightning can cause outages or damage electronic equipment. Extreme cold can freeze valves, pipes, and storage structures. Extreme heat can deplete water supplies and create a drought. High winds can damage structures and often cause power outages. The probabilities of extreme weather hazards are area-specific. Local weather bureaus can help determine probabilities of such events.

Waterborne Diseases

An outbreak of a waterborne disease caused by such organisms as *Giardia* or *Cryptosporidium* can contaminate an entire water supply. The Milwaukee, Wis., cryptosporidiosis outbreak in 1993 affected more than 350,000 people. Utilities can usually learn from state or provincial health departments which biological agents are most likely to affect them.

HUMAN-CAUSED DISASTER HAZARDS

The following paragraphs describe the most common human-caused disasters and the hazards associated with those disasters.

Hazardous-Material Releases

Any materials that can harm humans directly or contaminate air or water should be considered hazardous. The US Occupational Safety and Health Agency (OSHA) publishes a list of highly hazardous materials, toxins, and reactives (*Code of Federal Regulations* 29 CFR 1910.1000). Some hazardous materials, such as chlorine, are used in water treatment, others may not be used by utilities but may have the potential to be introduced into the system through means such as a transportation accident.

Spills can originate from pipelines, boats, airplanes, motor vehicles, railroads, or fixed containers. For example, in 1981, a crop-dusting plane carrying the herbicide 2,4-D crashed into a central California river not far from the water intake to a city water supply.

The spills may be of liquid, solid, or gaseous materials. They can occur at any time and can result in injury, loss of life, damage to property, and considerable costs to restore normal activity.

The most serious effect of hazardous spills to a water system is contamination of surface water and/or groundwater supplies. Emergency management must provide ways to keep spills out of the water system or to minimize the spread of contamination throughout the system. Damage to the water system and to water users affected by a spill can be very costly, not only in cleanup costs but in replacement of system components and potential lawsuits.

Structure Fires

A fire at a pump station or a treatment plant can seriously reduce a utility's delivery of water and can destroy many critical components, such as the computer control system. Fires may also destroy administrative buildings (including the equipment and records inside) and storage and maintenance structures. A large fire involving many structures or a wide area of a city can deplete water supplies through fire-fighting efforts.

Construction or Transportation Accidents

Accidents during construction can damage water system components, both aboveground and underground. All forms of transportation should be considered in emergency planning, including road, rail, water, and air. Such accidents may also disrupt traffic and block access to system components. Transportation accidents most likely will damage aboveground components.

Nuclear Power Plant Accidents or Nuclear Explosions

On April 26, 1986, the Chernobyl Atomic Power Plant in Ukraine exploded, spewing radionuclides (such as cesium-137 and strontium-90) into the air. Initially, the prevailing winds carried the radiation away from the city of Kiev, population 2.7 million. When the winds changed direction four days later, the radiation drifted toward Kiev. The city's main water supply, the Dnieper River and reservoir, was contaminated (Tsarik 1993).

The Chernobyl accident was the worst involving a nuclear power plant and is an unrealistic scenario in the United States. Radioactive contamination could also come from a less-explosive type of accident, such as a release of radioactive steam, water, or air from a plant or other nuclear facility. A detonation of a nuclear warhead could also cause widespread contamination.

The probability of a major radiation release from a nuclear power plant or warhead detonation is small. However, a utility near a nuclear plant or other facility, or even at some distance (Kiev is 62 mi [100 km] from Chernobyl) should consider radiation contamination in an emergency plan.

Vandalism, Riots, Strikes

Vandals can damage plants, pumping stations, dams, water towers, hydrants, and administrative offices For example, officials in West Virginia found a decomposing body in a water storage tank. They speculated that the person had drowned while vandalizing the tank (Petersen 1993). Civil unrest can be directed at water systems. Personnel may also be at risk of being killed or injured. Water supplies can be contaminated or intentionally depleted. Strikes by water utility or other workers can result in work stoppage or slowdowns, but may also result in vandalism, sabotage, interference of supply deliveries, or picket-line disturbances. Any system can potentially be affected by these hazards.

HAZARD SUMMARY

A hazard summary lists the disasters that can affect a water system, and the potential magnitude of the hazards associated with those disasters. Figure 2-7 is a sample form for a hazard summary. The form can be expanded or shortened to meet individual system needs.

Under "Estimated Probability" fill in the average occurrence interval of each disaster appropriate to your system (for example, once every 100 years). The estimated probability could also be more generally rated as low, medium, or high. By listing all of the disaster possibilities and rating their probabilities of occurrence, it is possible to establish priorities for planning.

Under the "Estimated Magnitude" heading, fill in the potential severity of the hazard using such measurements as Richter scale magnitude, wind speed, or flood elevation.

Type of Hazard	Estimated Probability	Estimated Magnitude	Comments
Earthquake	1 in 60 years	7.0 (Richter scale)	
Fault rupture	medium	2 ft	Meridian fault
Ground shaking	high		
Liquefaction	medium–low	vertical and horizontal accelerations	fill areas
Densification	medium		fill areas
Landslide	medium–high		in slopes of 30%
Tsunami and seiche	none		
Hurricane	none		
Wind			
Storm surge			
Flooding			
Tornados	low		
Floods	low–medium	100-yr. flood to elev. = 1,020 ft	at treatment plant
Forest or brush fires	high		Dry Creek watershed
Volcanic eruptions	1 in 300 years	150 mi away	Mt. Nueces
Other severe weather			
Snow or ice	none		
Extreme heat	high	100-yr drought	reservoirs depleted
Wind	medium	60–80 mph	usually in winter
Lightning	low		
Other			
Waterborne diseases	low		cryptosporidiosis
Hazardous-material release			
Chlorine	medium–high	1-ton containers	earthquake damage
Other spill	medium	tanker car	Dry Creek reservoir
Structure fires	low		
Construction accidents	medium	line damage	in older area of system

continued next page

Figure 2-7 Hazard summary for a hypothetical water system

Type of Hazard	Estimated Probability	Estimated Magnitude	Comments
Transportation accidents			
Road	low		
Rail	medium		rail yard near warehouse
Water	low		
Air	low		
Nuclear power plant accidents	low	contamination	Lake West reservoir
Nuclear bomb explosions	low		
Vandalism, terrorism	medium		storage tanks
Riots	low		
Strikes	low		

Figure 2-7 Hazard summary for a hypothetical water system (continued)

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