Is Your Solid Waste Infrastructure at Risk from Hurricanes or Flood Events?

Although some researchers have been warning us for decades that the "big" one is coming, many areas of the U.S. remain especially vulnerable. Make the time to assemble your team and review your facility's vulnerability to a major storm and, if warranted, put the wheels in motion to upgrade it accordingly.

By Bruce Clark and Marc Rogoff

As a solid waste facility owner/operator, if you were told tomorrow that a Category 4 or 5 hurricane was forecast to hit your facility head-on, could you say that the facility was prepared, not just for the wind, but also for torrential flooding as well? If your answer is "yes", skip this article. If it is "no", you may want to read on. The infrastructure for solid waste management, including landfills, waste-to-energy (WTE) plants and collection systems, has always been at risk for damage from natural disasters. This article will discuss coastal flooding from hurricanes, especially as they affect the U.S. eastern seaboard and the coastal Gulf states; however, some of the principles could also potentially apply to the west coast where there is the potential for a tsunami-triggered flood.

Some in the scientific community maintain that more extreme weather events are forecast as a result of climate change, which they believe is due to global warming. This article is not to debate global warming or climate change, but to examine:

- Which facilities may be at the most risk from these natural disasters;
- If that risk has increased, considering the experiences from recent high-profile natural disasters;
- Whether it is prudent for solid waste managers to assess their facilities for potentially significant damage and to evaluate if upgrades are warranted; and
- What contingency plans or changes should be made to prepare for a natural disaster.

Figure 1: Storm surge flooding scenarios SLOSH model. Figure courtesy of NWS.

Predicted Versus Actual Flood Elevation

The red portions of **Figure 1** show the area that would be inundated with a water level more than 9 feet above ground as a result of a Category 5 hurricane hitting at high tide. In many places, the area extends several miles inland, although it should be noted that storm surges have been recorded more than 25 miles inland (for example, Hurricane Ike that hit Texas and Louisiana and was "only" a Category 2 storm). The map is a product of computer simulations by a National Hurricane Center model. The model calculates storm surges from a varying set of storm characteristic parameters in dozens of regional grids and then prepares a composite overlay of the results. Although no specific hurricane would create the exact pattern on the map, the model does provide a better way to highlight the extent of vulnerable areas. Other computer models from the National Oceanic and Atmospheric Administration (NOAA) indicate that some coastal areas, such as Tampa Bay, could see a storm surge of 17 feet above land surface because of the configuration of small back bays that can amplify surge. Dozens of solid waste facilities, from waste-to-energy plants, to landfills, to transfer stations, to maintenance garages and fleet parking, fall within the red area on the map.

A coastal facility typically is designed with the first floor of the building no lower than the base flood elevation (BFE). The BFE is established at a flood level, including wave effects that have a 1 percent chance of being equaled or exceeded in any given year, also known as the 100-year flood, or base flood. The BFE is taken from Flood Insurance Rate Maps (FIRM) produced by the Federal Emergency Management Association (FEMA). Some recent natural disaster events have topped the predicted 100-year flood level, and even the 500-year flood level.

Figure 2, page 38, shows that there is a 25 percent probability that the 100-year flood will be exceeded within a 25-year period. Over a 40-year period (a period not uncommon for the useful life of some solid waste facilities), the probability increases to more than 30 percent. For the same period, there is an almost 20 percent probability of the 200-year flood and almost 10 percent probability of the 500-year flood.

Many solid waste facilities are decades old and were designed to older standards and based on FIRMs that now may be inaccurate. That can elevate their risk of damage. In addition, FIRMs, even more recent ones, may not depict the true BFE and the Special Flood Hazard Area (i.e., the 100-year flood plain). FIRMs do not account for upland development or topographic changes, shoreline erosion, wetland loss, subsidence,

sea level rise, changes in storm climatology, multiple events, and degradation of levees or seawalls. Any one of these factors can increase the actual BFE.

For example, take a look at Hurricane Sandy, which ravaged the Northeast in October 2012. The impacts of Hurricane Sandy were worse than the 500-year surge event predicted by calculations in an earlier February 2012 study on storm surge and climate change by researchers at MIT and Princeton. During Hurricane Sandy, the combination of the storm surge and astronomical high tides caused the peak storm tide at The Battery in Lower Manhattan to reach about 4.23 meters (more than 14 feet) above mean sea level. That was about 1 meter (3 feet) higher than the 500-year storm tide calculated in the 2012 study. The combined effects of changes in storm intensity and tracks that may occur as a result of climate change could cause the present-day 100-year surge event in New York to occur once every three to 20 years by 2100, and the present-day 500-year surge event to occur once every 25 to 240 years. That represents a significant escalation of storm surge risk, the study said.

Many local building codes have been or are being updated to recognize these findings and incorporate new recommendations based on experiences with natural disasters over just the past 10 years. For example, a commonly referenced document in some Codes is The American Society of Civil Engineers (ASCE) Standard 24-14, Flood Resistant Design and Construction. That document recommends that the lowest finished floor and utilities of a Flood Design Class 3 facility (which includes water and sewage treatment plants as essential facilities, and could be argued to include perhaps a WTE plant) be up to 2 feet above the BFE. Although your facility may be exempt from the new requirements because of its age, that may not be a good reason to ignore the damage caused by recent storms; it is worth at least considering what your vulnerability may be.

Your area may not have experienced a powerful storm in decades and, thus, the design of facilities may not be up to current standards. This is another good reason to consider assessing where you stand in terms of preparedness. The Tampa Bay area of Florida, for example, has not experienced a direct hit from a hurricane in 60 years. It is only a matter of time.

Damage from Flooding at Facilities

We spoke with some solid waste facilities operators to get a sense of their plans to prepare for severe storms, and what kinds of damage they have experienced from coastal flooding events. Damage at landfills has been relatively minor, mainly because relatively little infrastructure at a landfill is installed at grade level. Typically, the scalehouse, maintenance building and blower flare station may be built closest to existing grade, whereas filled areas have the benefit of the earthen dike that encloses the waste and can provide a significant barrier against intrusion of a flood surge. However, gas management, storm water control and leachate management facilities have been overwhelmed by certain flooding events and sustained some damage. Fleet parking lots also have experienced flooding, and parked vehicles have been damaged as a result of saltwater contact.

These experiences are highly dependent on local factors, and even though some facilities have managed fairly well during powerful storms, every storm is different. Complicating factors such as the wind, tide, prior rainfall in the region and other events, including rapid changes that affect the angle at which the storm hits can amplify the effects of any storm. One landfill in the southeast experienced a significant flooding event but had relatively little lasting damage. All of its retention areas were overwhelmed due to a few weeks of wet weather followed by one day of hard rain where up to 4 inches fell per hour. That rainfall event was considered less than the 25-year storm, which is a typical design criterion in that region. So, in some cases it may not even take a hurricane to produce flooding and significant damage.

At least one major facility operator indicated that they do not have a specific plan for ensuring their facility is prepared for and can function in a severe storm. The only plan they had was a response-type plan that spelled out how

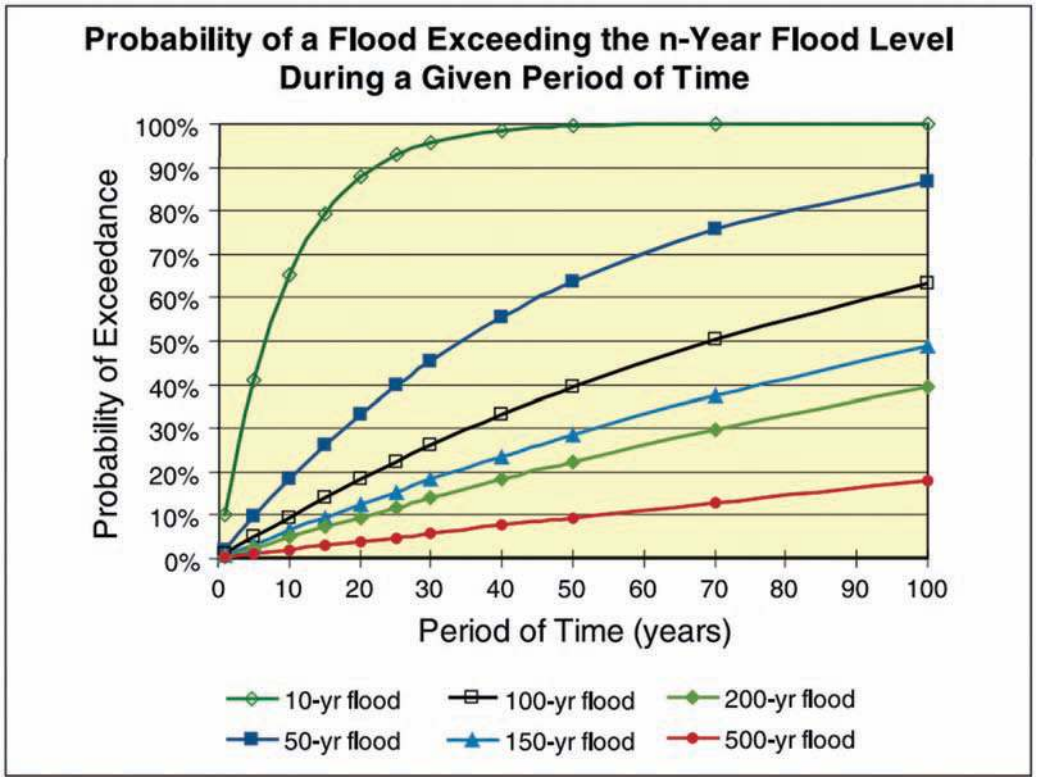

Figure 2: Home Builder's Guide to Coastal Construction Technical Fact Sheet No. 1.6.
Figure courtesy of FEMA.

they would recover from the disaster.

What Can You Do to Prepare?

So what can a solid waste facility operator do in light of the unpredictability of damage from severe storms, facilities that were built based on potentially out-of-date FIRM maps, reports of sea level rise and its affects when combined with storms, and other concerns? You may want to consider some additional planning that assesses the vulnerability of your facility before the next storm hits. Depending on your specific situation, some initial recommendations may include:

1. Identify critical facilities that need to continue to function or cannot be offline for an extended period of time.
2. Identify other facilities that may be non-essential, but would be expensive or difficult to replace if damaged.
3. Assess the critical facilities, including structures, electrical switchgear and mechanical equipment that are potentially at risk of being flooded and damaged, and the extent that they would have to be replaced or would entail significant, costly repair.
4. Assess the condition of your storm drainage facilities.
5. Assess if critical buildings have foundations that are compatible with potential storm surge forces
6. Assess the vulnerability of fleet parking areas.
7. Identify the currently predicted BFE for your area and the requirements and other recommendations for the minimum elevation of new construction and compare that to your facilities.
8. Check with your insurer about their current requirements and compare that to existing conditions.

Depending on what you find at this preliminary stage, it may be useful to develop an action plan with your team to assess risk versus benefits and cost and to prioritize potential changes and upgrades in order to provide a more appropriate level of protection. Action items could include:

1. Reviewing any recent recommendations from your risk management department and insurer, and whether or not they have been implemented.
2. Evaluating the need for foundation improvements or other types of protection for critical buildings.
3. Returning drainage features and controls to their original depths and widths,

and ensuring that protective linings and other energy dissipation features are intact, and that outlet structures are not compromised or blocked.

4. Determining whether vehicles that would be inundated could be relocated to adequate higher ground ahead of a storm.
5. Evaluating the measures that would be required to move critical plant equipment to a higher elevation.
6. For equipment that cannot be moved, assessing if it can be placed inside a permanent, inflatable or another type of protective dike system.
7. Evaluating the construction of permanent walls or other barriers to route

floodwater around critical areas and structures.

8. Evaluating the construction of additional or enlarged drainage systems.

Put the Wheels in Motion

Although some researchers have been warning us for decades that the "big" one is coming, many areas of the U.S. remain especially vulnerable. The reality is that the U.S. has experienced some powerful storms over the past 10 years alone that have produced devastating effects that few were really prepared to handle. Although you have many priorities managing your business on a daily basis, as a prudent professional you need to make the time to assemble your team and review your facility's vulnerability to a major storm and, if warranted, put the wheels in motion to upgrade it accordingly. | WA

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