Natural disasters like Hurricanes Katrina, Harvey, and Irma, have shown that managing disaster debris and waste is a challenging part of disaster response and recovery. These types of disasters, and other extreme weather events like the floods in Ellicott City, MD, generate large volumes of debris and waste that can overwhelm existing waste and debris management (WDM) processes and infrastructure. WDM is a complex multistep process that includes segregation, staging, transport, reuse, recycling, and disposal. Pre-incident planning and implementation of that plan can lead to a smoother response and recovery, however, recent natural disasters have also shown that even in areas where states, local governments, tribes, and territories had developed plans for managing disaster waste and debris pre-incident (e.g., Puerto Rico), the magnitude of debris and waste that was generated far exceeded the scale at which those plans were designed.

Planning Mitigates Post-Incident Problems
Not following a carefully developed plan could result in bringing unplanned WDM resources into an area, thus increasing the number of times debris is handled, and the number of transporters, waste management staging sites, and disposal facilities. This causes delays and increased costs. WDM decisions might also be rushed, leading to efforts that are often not sustainable.

Another challenge is scalability of the plans both in terms of the size of the incident and the number of impacted jurisdictions. It is recognized that some decision-makers may not have an accurate understanding of the waste amounts, types, and generation rates during the response and recovery phases and/or they lack the resources to conduct informed and detailed planning needed to construct scalable plans.

Incidents involving extremely hazardous contaminants (e.g., a chemical, biological, radiological, nuclear incident), present even larger challenges. For example, a federal regulatory framework for biologically-contaminated waste (e.g., Bacillus anthracis) does not currently exist, and there is a limited disposal capacity for radiologically-contaminated waste. In addition, some waste disposal facilities lack familiarity with these types of waste and can refuse acceptance of any waste.

For large-scale contamination incidents, the consequences of not considering waste when making other cleanup decisions (e.g., selection of decontamination methods) introduces additional downstream challenges. Recovery after the Fukushima Nuclear Power Plant accident is a perfect example of creating waste management challenges through cleanup decisions. This accident resulted in more than 9,000 square miles of radiation levels that exceeded...
Waste generated during decontamination operations as radioactive decontamination waste (instead of surveying the material to segregate it so that some of it could be reused, recycled, or at least disposed of in existing landfill). This led to the generation of contaminated soil.

In response to these challenges, the U.S. Environmental Protection Agency (EPA) has developed a suite of WDM-related decision-support and planning tools. These tools support decisions such as where to dispose or recycle the waste and debris, where to stage the waste, and for development of remediation strategies.

**EPA Waste and Debris Management Tools**
The suite of EPA decision-support tools for waste and debris management is illustrated in Figure 1. Real-world applications of the EPA tools I-WASTE, Disaster Debris Recovery Tool (DDRT), and Waste Estimation Support Tool (WEST) are highlighted below.

**I-WASTE**
- Used to identify waste management facilities in North and South Carolina and Virginia that might have been impacted by Hurricane Florence as well as to find facilities broadly available in EPA Regions 3 and 4 for disposal of the disaster waste. Facility maps were coupled with other maps, showing flooding, to help assess which waste management facilities might be adversely impacted by the storm.

**DDRT**
- Has been used to help construct disaster debris management plans. For example, the Mille Lacs Band of Ojibwe Tribe, located in central Minnesota with a contiguous reservation to five nearby communities, used DDRT to search for landfills, tire recycling, electronics recycling, composting, and other facilities using a 50-mile buffer in and around the reservation.

**WEST**
- Was used to provide waste quantity estimations for several national level exercises. One of these focused on a notional radiological dispersal device containing 2,300 curies (units of radioactivity) of cesium-137 dispersed over approximately 100 km² in Philadelphia, PA, via a 1,360-kg truck bomb. The tool provided an estimate of the volumes and types of waste that would need to be managed (see Figure 2), allowing EPA’s response to be realistically exercised. Although WEST was developed to create waste estimates for radiological and biological contamination incidents, it has been used to create debris estimates for natural disasters.

**Remaining Gaps in Decision Support**
The continuous recovery efforts beckon the need for sustainable materials management practices such as recycling, reuse, and construction of a more resilient built environment. The current tool set does not address all...

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**Figure 1.** EPA’s suite of waste and debris management (WDM) and sustainable materials management (SMM) tools. All tools, except for the tools shown in the top middle circle, are configured to support WDM decisions in their current form.
aspects of sustainable material management (SMM), particularly the avoidance of waste and debris through better building standards and supporting development of practices for recovery of materials post-disaster for reconstruction and other uses.

**Future Vision**

EPA is working to improve the usability, accessibility, and functionality of this WDM tool set for WDM decision-makers by linking, integrating, and facilitating data exchange between the tools and addressing remaining decision support gaps. The Waste Management Pre-Incident Planning Tool, described in Figure 1, walks end users through the creation of a site-specific WDM plan. The vision is for this tool to serve as the user interface while the other tools provide the needed information.

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**References**


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**More Information**

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