

PLANNING FOR NATURAL DISASTER DEBRIS



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About This Document

- This document supersedes the “Planning for Natural Disaster Debris” guidance published by the United States Environmental Protection Agency (EPA) in 2008 (Document ID Number EPA530-K-08-001). Changes from the 2008 version include:
 - Reorganization of content based on EPA’s *Pre-incident All-hazards Waste Management Plan Guidelines: Four-step Waste Management Planning Process*, which is described in the document;
 - Heavier focus on preliminary and pre-planning efforts related to natural disaster debris management;
 - Incorporation of the impacts that community resiliency, climate change adaptation, and hazard mitigation efforts have on disaster debris management; and
 - Addition of new case studies on the responses to the 2011 Joplin tornado, 2012 Hurricane Sandy in New York City, and 2015 St. Louis Area floods.
- This guidance supports EPA’s responsibilities under the National Response Framework (NRF), which aims to help the whole community (i.e., all government and nongovernment stakeholders) prepare for, respond to, and begin short-term actions to recover from a disaster or an incident, including those that may require a coordinated Federal response. Specifically, as a designated support agency under the NRF’s Emergency Support Function (ESF) #3 – Public Works and Engineering Annex, EPA provides technical assistance for nonhazardous waste management, including debris management and recycling and reuse opportunities, and expertise on waste and debris disposal options, among other actions.
- EPA develops regulations, guidance, and policies that promote the safe management and cleanup of solid and hazardous waste, as well as programs that encourage source reduction and beneficial reuse, under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §§ 6901–6992k) and its regulations (40 CFR parts 240–282).
- EPA recommends preparing comprehensive debris management plans before a natural disaster occurs. This document is designed to assist communities (i.e., cities, counties, tribes, etc. working in conjunction with the whole community, including federal, state, local, and tribal agencies) in developing these plans and includes information on the following:
 - Recommended components of a debris management plan.
 - Suggested management options for various natural disaster debris streams.
 - A collection of case studies that highlights how several communities prepared for and managed debris generated by recent natural disasters.
 - Federal, state, and local resources to consult in planning for natural disasters.
- This document discusses the management of debris from natural disasters, including hurricanes, earthquakes, tornadoes, volcanoes, floods, wildfires, and winter storms. It does not discuss the management of debris from acts of terrorism or other homeland security

incidents (e.g., foreign animal diseases); however, the information contained within this document may be helpful when preparing for those types of incidents.

- In general, only federal regulations are discussed in this document where applicable. State, tribal, and local governments may have more stringent regulatory requirements. State, tribal, and local officials should be consulted to ensure compliance with those regulations. The information in this document is subject to change as federal regulations and recommendations change as new information becomes available.
- Additional resources:
 - EPA’s Managing Materials and Wastes for Homeland Security Incidents: <https://www.epa.gov/homeland-security-waste>.
 - The Federal Emergency Management Agency’s (FEMA’s) “Public Assistance Program and Policy Guide” (FP-104-009-2) was revised in January 2018. Communities should consult this document to help ensure their debris management plans will be eligible for public assistance from the federal government when applicable: <https://www.fema.gov/media-library/assets/documents/111781>.

Disclaimer

This document is not a regulation. It does not change or substitute for any legal requirement. This document is not a rule, is not legally enforceable, and does not confer legal rights or impose legal requirements upon any member of the public, states, tribes, or any other federal agency. This document uses the word “should” to describe EPA recommendations or suggestions; it does not connote a legal requirement.

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“Every disaster is different, but a plan will give you a place to start.” – Marc Bruner, Solid Waste Authority of Palm Beach County

“Disasters are come-as-you-are battles. Having a plan will make you more prepared when the battle comes.” – John Rogers, Louisiana Department of Environmental Quality

Cover photographs (from the top): curbside pickup of debris in Missouri after the 2015 floods; debris field in Greensburg, Kansas after the 2007 tornado; vegetative debris mulching operation in Louisiana after Hurricane Katrina (courtesy of the Department of Environmental Engineering Sciences at the University of Florida).

Acronyms

ACI	air curtain incinerator
ACM	asbestos-containing material
ASTSWMO	Association of State and Territorial Solid Waste Management Officials
BMRA	Building Materials Reuse Association
C&D	construction and demolition
CAMEO	Computer-aided Management of Emergency Operations
CCA	Chromated Copper Arsenate
CDRA	Construction & Demolition Recycling Association
CFR	Code of Federal Regulations
CRT	cathode ray tube
DHS	U.S. Department of Homeland Security
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DSNY	New York City Department of Sanitation
e-waste	electronics waste
EMAC	Emergency Management Assistance Compact
EMI	Emergency Management Institute
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESF	Emergency Support Function
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FLASH	Federal Alliance for Safe Homes
FWS	U.S. Fish & Wildlife Service
GIS	Geographic Information System
H ₂ S	hydrogen sulfide
Hazus-MH	Hazards U.S. Multi-Hazard
HHW	household hazardous waste
HUD	U.S. Department of Housing and Urban Development
I-WASTE	Incident Waste Decision Support Tool
LDEQ	Louisiana Department of Environmental Quality
LEPC	Local Emergency Planning Committee
MDEQ	Mississippi Department of Environmental Quality
MDP	Marine Debris Program
MRF	materials recovery facility
MSW	municipal solid waste
NAA	No Action Assurance

NCP	National Oil and Hazardous Substances Pollution Contingency Plan, more commonly called the National Contingency Plan
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NHSM	non-hazardous secondary material
NOAA	National Oceanic and Atmospheric Administration
NRC	National Response Center
NRF	National Response Framework
NYC	New York City
PA	Public Assistance
PAPPG	Public Assistance Program and Policy Guide
PCB	polychlorinated biphenyl
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
SAM	System for Award Management
SWA	Solid Waste Authority
SWANA	Solid Waste Association of North America
TEPC	Tribal Emergency Planning Committee
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WBUG	Woody Biomass Utilization Group
WM	Waste Management
WMP	Waste Management Plan

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I Introduction

Every year, natural disasters, such as wildfires, floods, earthquakes, hurricanes, tornadoes, and winter storms, challenge American communities. For example, in 2017, the United States experienced, in a one-month period, three separate destructive hurricanes that impacted a large area of the United States (U.S.) and its territories – Hurricane Harvey (August 2017), Hurricane Irma (September 2017), and Hurricane Maria (September 2017). These hurricanes represent only a few of the natural disasters that occurred that year, which also included the northern California firestorm (October 2017) and tornadoes across the South (January 2017) and Midwest (March 2017). In addition to addressing the loss of power, homes, and lives from natural disasters, communities are tasked with the difficult job of managing the large amounts of natural disaster debris that may be generated by these disasters. Natural disaster debris refers to the material and waste streams resulting from a natural disaster. Disaster debris often includes building materials, sediments, vegetative debris, and personal property. Large quantities of debris can make recovery efforts difficult by, for example, hindering emergency personnel, damaging or blocking access to necessary infrastructure, and posing threats to human health and the environment.

Cleaning up this debris can be time-consuming and costly, extending the recovery from the disaster. According to the Federal Emergency Management Agency (FEMA), Hurricane Katrina, one of the most catastrophic natural disasters in U.S. history, resulted in more than 99 million cubic yards of debris, totaling greater than \$3.7 billion in debris removal costs alone (<https://www.fema.gov/news-release/2006/08/22/numbers-one-year-later>). The National Oceanic and Atmospheric Administration (NOAA) estimates that from 1980-2017, the U.S. has experienced 219 natural disasters that resulted in at least \$1 billion in damages, costing the U.S. more than \$1.5 trillion. Ten of these disasters occurred in 2015; fifteen of these disasters occurred in 2016. In 2017, sixteen of these disasters occurred, resulting in the most expensive year on record for disasters with \$306.2 billion in cumulative damages. This total replaces the previous annual record cost of \$214.8 billion (adjusted for inflation), which was established in 2005 due to the impacts of Hurricanes Dennis, Katrina, Rita and Wilma. (NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2018): <https://www.ncdc.noaa.gov/billions/>.) According to the 2014 National Climate Assessment, which is a detailed report on climate change impacts on the U.S., climate change is expected to increase the frequency and intensity of some natural disasters (http://s3.amazonaws.com/nca2014/low/NCA3_Climate_Change_Impacts_in_the_United%20States_LowRes.pdf?download=1). The amount of debris generated by natural disasters, and the costs to manage it, will likely increase as a result.

Natural disaster debris management may involve the whole community, including individuals and families, businesses, faith-based and community organizations, nonprofit groups, schools and academia, media outlets, and all levels of government. The National Preparedness Goal 2nd Edition (2015) defines “whole community” as a focus on enabling the participation in national preparedness activities of this wide range of players in order to foster better coordination and working relationships (<https://www.fema.gov/media-library/assets/documents/25959>). For

example, when planning for natural disaster debris, communities should collaborate with federal, state, local, tribal, and other stakeholders to help ensure an integrated and effective approach. More information on the concept of whole community may be found at <https://www.fema.gov/whole-community>.

Communities that may benefit from the advice presented in this document include:

- Communities at risk of significant damage from a natural disaster.
- Communities at increased risk from natural disasters due to climate change.
- Communities currently without an existing or comprehensive debris management plan.
- Communities with emergency response plans that overlook disaster debris cleanup or consider only a limited number of debris management options.
- Communities in the beginning stages of the debris management planning process.
- Communities with existing debris management plans that have not been updated with new information, such as reductions in existing disposal capacity or innovative reuse or recycling opportunities.

After a natural disaster strikes, a community, working with federal and state officials and other stakeholders, must conduct many debris management-related activities before it can fully recover, such as:

- Estimating debris quantities;
- Assessing debris management options;
- Triaging debris management;
- Segregating debris into different material and waste streams;
- Identifying debris management sites and facilities and their available capacities;
- Collecting and hauling debris from the field and/or curb;
- Removing debris from waterways and sensitive habitats (e.g., shorelines, wetlands, marshes);
- Sampling and analysis of debris;
- Characterizing debris for proper management;
- Obtaining emergency permits;
- Processing debris (e.g., volume reduction, refrigerant removal);
- Packaging and labeling debris for transport;
- Transporting debris to debris management sites and facilities;
- Managing debris through reuse, recycling, treatment, and/or disposal;
- Monitoring incoming debris at debris management sites and facilities;
- Tracking debris from the original deposited point to final destination;
- Conducting debris management oversight activities, such as site visits to, inspections of, and environmental monitoring at debris management sites; and
- Communicating with the public about debris collection and other management activities.

Pre-incident debris management planning by communities, such as forecasting debris volumes and types, identifying available capacity, developing debris management options, and defining

roles and responsibilities for all debris management-related activities can help facilitate these activities.

Large-scale natural disasters may generate debris in quantities greater than the amount of waste many communities handle each year. While this document does not provide all the information a community may need to plan for natural disaster debris, this document draws from communities' experiences and provides planning recommendations for managing natural disaster debris. The suggestions within this document can be adapted, as necessary, to each community's unique situation. The primary goal of pre-incident debris management planning should be to prepare the community to manage natural disaster debris effectively in coordination with the whole community (i.e., all governmental, private, nonprofit, community, and other stakeholders). In addition to helping the community prepare for managing debris generated by natural disasters, pre-incident planning can encompass community resilience, source reduction, and hazard mitigation activities aimed at reducing the amount of time it takes a community to recover, the total amount of debris generated, and the release and exposure to potentially harmful components in the debris.

Pre-incident debris management planning provides many benefits, such as:

- Saves valuable time and resources during a response to a disaster;
- Allows more efficient, effective, and environmentally responsible waste management decision-making during a disaster;
- Encourages stakeholders (e.g., state, local, tribal, and territorial governments, owners of private storage, treatment, and disposal facilities, residents) to work together before a disaster occurs;
- Boosts the community's resiliency in the wake of a disaster and positions it for a quicker and less costly recovery to its pre-incident state;
- Enhances the community's adaptation to the debris-related impacts of climate change; and
- Minimally detracts from, or otherwise impacts, the broader response and recovery efforts due to the efficient implementation of debris management activities.

The United States Environmental Protection Agency (EPA) strongly recommends that pre-incident planning be documented in a debris management plan. Although the officials who contributed to this document recognize that even the best debris management plan cannot account for every situation, having a plan is important because it lays the groundwork for a community's preparedness and response to a natural disaster, particularly if it has widespread impacts. In order to be comprehensive, communities are encouraged to develop debris management plans that are scalable to both large and small natural disasters. Planners can follow EPA's comprehensive All-hazards Four-step Waste Management Planning Process, which is described in Section 2, or, if resources and time are limited, can focus on one or more pre-incident planning activities at a time. Debris management planning activities that may provide the greatest benefit for a community that has limited resources and time to devote to planning include the following:

- Consult with key stakeholders and sectors, including transportation, sanitation, emergency response, environmental, agricultural, public health, public works, zoning, and other industry and business leaders.
- Identify potential debris streams, including harmful constituents, and possible quantities that may be generated by a disaster considering the industrial, agricultural, residential, and commercial zones in the community.
- Evaluate existing reuse and recycling programs to determine if they can be scaled up to handle disaster-related wastes.
- Consider waste collection strategies, such as separating the debris into different waste streams before transporting it off-site.
- Determine locations (or criteria) and capacities for debris management sites that are suitable for debris staging, temporary storage, and decontamination activities.
- Select potential reuse, composting, recycling, treatment, and disposal facilities, including mobile treatment units, that are currently available to the community, state, and region and assess their daily and long-term capacities.
- Create a debris management-focused community outreach plan.
- Address health and safety considerations for debris management operations (e.g., handling orphaned tanks, animal carcasses, asbestos-containing materials, quarantined materials like pest-infested vegetative debris, and hazardous chemicals from school chemistry labs, medical offices, and hospitals).

Each planning activity can also be divided into more manageable pieces. For example, a community wanting to increase the amount of debris recycled after a natural disaster can address one debris stream at a time. Planning is not an all-or-nothing effort. Small but significant steps taken prior to an incident can have a big impact on the efficiency and effectiveness of post-disaster debris management decision-making.

Although the recovery process may take a long time, perhaps even years, careful planning can:

- Significantly minimize the potential for costly mistakes;
- Speed recovery;
- Protect human health and the environment; and
- Prevent the generation of additional waste.

For example, the number of times debris is handled, the number of transporters, waste management sites, and facilities needed, and the cost and environmental impact of the disaster can all be minimized through thorough and detailed planning prior to the incident. Additionally, having a sound, comprehensive debris management plan can expedite removal of debris—an important sign of recovery that residents will see. Expedited removal also reduces dangers of fire, personal injury, and disease vectors.

2 Planning Process for Natural Disaster Debris

To prepare for the volumes and the types of debris that may be generated, communities, in coordination with the whole community, are encouraged to plan for natural disasters they may experience. Effective planning addresses:

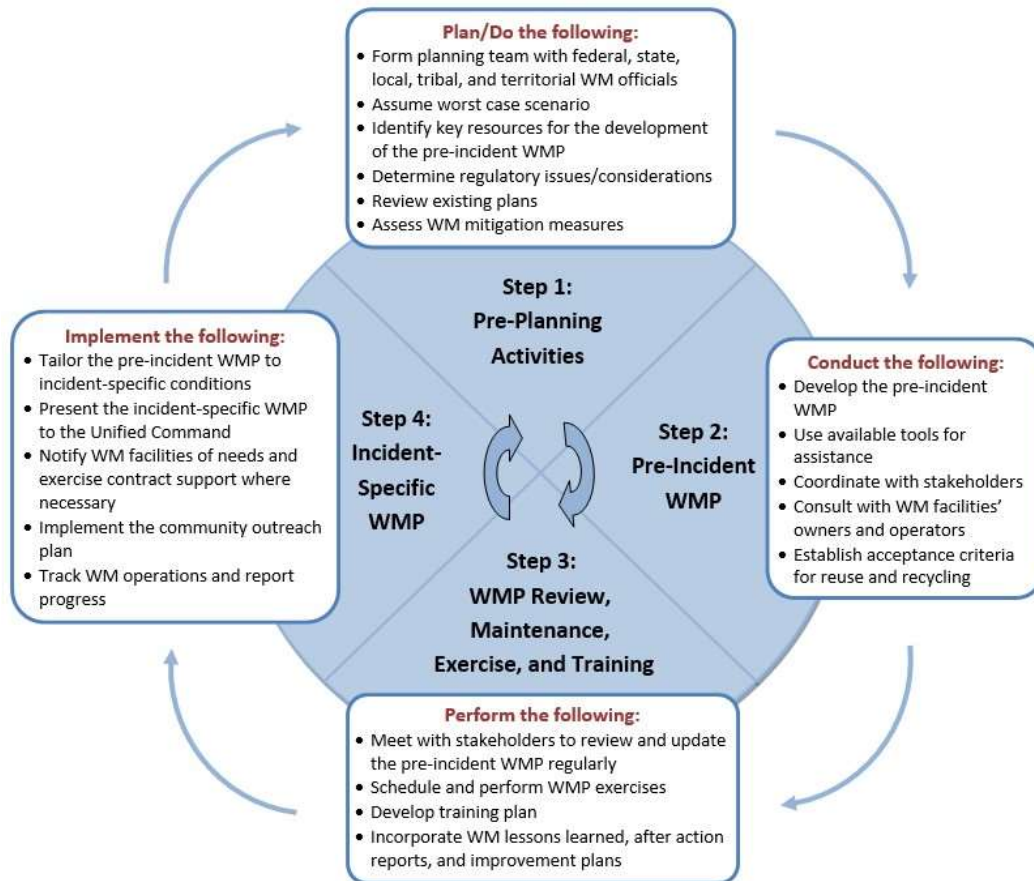
- Source reduction and hazard mitigation activities to reduce the amount and toxicity of debris generated by a natural disaster;
- Strategies for reuse and recycling of materials to minimize the environmental and economic impact of debris management activities;
- Roles and responsibilities for all debris management and related activities; and
- Issues and considerations beyond initial debris removal.

Based on lessons learned and insights from community officials who have conducted debris cleanup after a natural disaster, EPA developed a comprehensive, pre-incident planning process to help prepare communities for effective disaster debris management. This recommended process guides communities through four steps, which should be undertaken with the participation of the whole community:

- 1) Conduct pre-planning activities;
- 2) Develop a comprehensive pre-incident debris management plan;
- 3) Keep the debris management plan updated; and
- 4) Implement the debris management plan during a natural disaster.

Each step is discussed in detail below. Bear in mind that the debris management planning process does not have to be completed at one time or by one person. Disaster debris management planning usually requires input from the whole community, including neighboring communities, state officials, industry representatives, contractors, waste management facilities, a variety of local agencies, volunteer organizations (e.g., the American Red Cross, faith-based organizations), and other stakeholders. Figure 1 summarizes EPA's suggested planning process for initiating, creating, updating, and implementing a comprehensive and scalable waste (or debris) management plan (WMP).

Figure 1. Pre-incident Waste Management (WM) Planning Process



2.1 Conduct Pre-planning Activities

The first step of EPA’s recommended planning process is conducting pre-planning activities. While one person may begin planning, this planner will likely need assistance throughout the planning process from a team of people with different areas of expertise. Generally, planners should establish how the debris management plan will be created, what will be included in the plan, and who, beyond the team, should review it. Reviewers may include neighboring communities or state and federal officials. A planner may want to begin by identifying and engaging with individuals and groups who should be involved in the planning process as appropriate. Individuals or groups who represent transportation, sanitation, emergency management and response, environment, agriculture, public health and safety, public works, zoning, industry, and business, among others, should be consulted. The team may also include officials from other communities that have experienced disasters. This team can help identify unique, local circumstances and issues that may affect debris management during a disaster, such as geography, sensitive populations, and union and other contract or worker issues.

Successful Collaborative Planning

NOAA's Marine Debris Program (MDP) worked with state and local governments and other stakeholders to address potential acute waterway debris incidents affecting Florida's coastline. (Acute waterway debris incidents involve the release of large amounts of debris into waterways as a result of natural or manmade incidents, including natural disasters.) This collaboration resulted in the development of the Florida Marine Debris Emergency Response Guide (https://marinedebris.noaa.gov/sites/default/files/publications-files/FL_Marine_Debris_Emergency_Response_Guide_Comprehensive_Guide_0.pdf). The purpose of this guide is to improve preparedness for response and recovery operations following an acute waterway debris incident on the Gulf or Atlantic coast of Florida. Since its development, the guide has been heavily utilized by state and federal government responders.

Planners should focus on preparing for those disasters that are likely to happen in their communities. However, planners should not rely solely on historical information to determine the risks to their communities because the past is not a reliable predictor of future conditions under a changing climate. Recorded changes in temperature, precipitation, and wind patterns, for example, are causing extreme weather events that are creating new risks to communities and sites. More frequent and intense storms, flooding, storm surges, droughts, and wildfires—and combinations of events—may generate larger amounts of debris. Examples of the types of debris that may be generated include vegetative debris (e.g., brush and trees), animal carcasses, construction and demolition (C&D) debris, orphaned tanks (i.e., abandoned tanks with no known or financially viable owner), marine or waterway debris, sediment, vehicles, white goods (i.e., household appliances, such as stoves, refrigerators, washers/dryers, air conditioner units), and electronics waste (e.g., computer equipment, cell phones).

The most common natural disasters that plague communities around the U.S., causing injury and loss of life in addition to generating debris, include the following:

EARTHQUAKES are caused by a sudden movement of the earth's crust. Generally, most destruction is closest to the epicenter, radiating damage outward. Earthquakes are more likely to occur in Alaska, Hawaii, and the western part of the U.S.; however, induced earthquakes are becoming more frequent in the central and eastern U.S. (<https://earthquake.usgs.gov/research/induced/>). Additionally, dormant fault lines in other areas may become active at any time. The U.S. Geological Survey (USGS) maintains seismic hazard maps that provide the most up-to-date information on earthquake hazards (<https://earthquake.usgs.gov/hazards/hazmaps/>).

FLOODS occur when excess water submerges land, such as from prolonged heavy rains or changes in the environment (e.g., land development) around streams, rivers, and coastal areas that reduce the ability of the ground to absorb water. Floods can occur in coastal and inland areas, making them the most common natural disaster in the U.S. Climate change may intensify flooding across the U.S., even in areas where total precipitation is projected to decline

(<http://nca2014.globalchange.gov/report/sectors/water>). The FEMA Flood Map Service Center provides tools to understand an area's flood risk (<https://msc.fema.gov/portal/>). FEMA is also working with federal, state, local, and tribal partners to identify flood risk and help reduce that risk using Risk Mapping, Assessment and Planning (Risk MAP) (<https://www.fema.gov/risk-mapping-assessment-and-planning-risk-map>). Additionally, NOAA's Office of Water Prediction collaboratively researches, develops, and delivers state-of-the-science national hydrologic analyses, forecast information, data, decision-support services, and guidance to support and inform essential emergency services and water management decisions (<http://water.noaa.gov/> and <http://water.weather.gov/ahps/>).

HURRICANES are severe tropical storms that form in the ocean and can make landfall along coastal communities in the U.S., bringing with them winds of at least 74 miles per hour, heavy rains, and large waves that can damage trees, buildings, and infrastructure. Hurricane-associated storm intensity, frequency, and duration have substantially increased since the 1980s and are projected to continue increasing as the climate warms (<http://nca2014.globalchange.gov/report/our-changing-climate/changes-hurricanes>). NOAA maintains the National Hurricane Center (<http://www.nhc.noaa.gov/>) and Central Pacific Hurricane Center (<http://www.prh.noaa.gov/cphc/>) to provide forecasts and warnings for tropical cyclones in the Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and Eastern and Central Pacific Ocean, including some of the resulting hazards, such as storm surge.

TORNADOES appear as funnel-shaped clouds that extend from a thunderstorm to the ground with rotating winds. While tornadoes occur in every state of the U.S., Florida and "Tornado Alley" in the south-central U.S. experience a disproportionately high frequency of tornadoes. NOAA provides data on the average number of tornadoes by state over a 20-year period (<https://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology>).

TSUNAMIS, also known as tidal waves or seismic sea waves, are a series of waves in a water body, generally in an ocean or a large lake. The tsunami wave may come gently ashore or may increase in height to become a fast moving wall of turbulent water several meters high. Unlike normal ocean waves, which are caused by wind or tides due to the gravitational pull of the moon and the sun, a tsunami wave is generated by a sudden displacement of a large volume of water caused by earthquakes, volcanic eruptions, underwater explosions, landslides, glacier calving, meteorite impacts, and other disturbances above or below water. Tsunamis are a threat to coastlines, particularly in the Northwest. More information on tsunamis can be found on NOAA's tsunami website at <https://www.tsunami.noaa.gov/>.

WILDFIRES are large, unplanned fires that spread rapidly in natural areas like forests, grasslands, and prairies. They can occur anytime and anywhere, especially in areas with little or no rainfall for a prolonged period of time. More intense droughts and warmer temperatures cause larger wildfires and longer fire seasons (<http://nca2014.globalchange.gov/highlights/overview/overview>). The USGS maintains the Geospatial Multi-Agency Coordination (GeoMAC) tool, which provides maps of current fire locations and perimeters in the U.S. (<https://www.geomac.gov/about.shtml>).

WINTER STORMS are events that include large amounts of snow, sleet, or freezing rain. Areas with below freezing temperatures are at risk of winter storms. Since the 1950s, winter storms have become more frequent and intense and have shifted northward over the U.S. (<http://nca2014.globalchange.gov/report/our-changing-climate/changes-storms>).

VOLCANOES are mountains through which gases and molten rock erupt. In the U.S., active volcanoes are located mainly in Hawaii, Alaska, and the Pacific Northwest. The USGS maintains the Volcano Hazards Program, which provides current information on potential hazards (<https://volcanoes.usgs.gov/index.html>).

2.1.1 Enhance Community Resiliency to Minimize Debris Generation

A resilient community is more sustainable because it has the ability to better withstand and recover more rapidly from natural disasters. In the event of a disaster, a resilient community:

- Generates less debris to manage.
- Contains less harmful materials that can be released, which minimizes hazardous debris.
- Recovers faster, encouraging residents and businesses to stay in the area.
- Reduces disruption of critical services, including power and water.
- Spends less money on cleanup and debris management.
- Uses fewer resources to rebuild and recover.

Communities should thus work to increase their resiliency to the effects of natural disasters that they are likely to experience. This concept is also strongly emphasized in the National Disaster Recovery Framework, Second Edition (<https://www.fema.gov/national-disaster-recovery-framework>). Stronger winds, more powerful storm surges, more frequent floods, and heavier rains have the potential to cause greater damage and, therefore, debris. Greater quantities of debris on land and in water may slow down the disaster response and increase the recovery time and cleanup costs. Boosting resiliency to natural disasters is an important way that communities can adapt to more frequent and severe storms.

While total prevention of debris may not be possible, communities should begin implementing strategies for decreasing the overall amount and toxicity of potential debris before a disaster occurs to increase their resiliency to natural disasters. Communities should identify what potential hazards exist within their borders, including determining and locating facilities that use and store hazardous substances or oil. Planners should then identify opportunities for:

- Source reduction (e.g., updating building codes for resilient building design and construction);
- Hazard mitigation (e.g., eliminating potential problematic wastes, such as retrofitting polychlorinated biphenyl (PCB) transformers to reduce PCB-contaminated wastes; implementing adequate advance measures for fueling stations and tank farms to control releases); and
- Increased reuse and recycling (e.g., finding end markets for potential debris streams).

Communities may also want to create an outreach program to educate the public on how they can decrease the amount of damage their properties might suffer in a natural disaster. See Figure 2 for suggestions on enhancing residential resiliency.

Figure 2. Enhancing Residential Resiliency

Residents can take certain actions to limit the damage to their homes during natural disasters, decreasing the amount of debris generated:

- Brace hot water heaters to keep them from toppling and rupturing gas lines to prevent fire outbreaks.
- Strengthen walls, foundations, and chimneys to limit damage.
- Bring inside or secure (e.g., with ground anchors or straps) all outdoor objects, such as trash cans and recycling bins, patio furniture, grills, and lawn ornaments (e.g., garden gnomes), to reduce potential projectiles and debris. If trash cans and recycling bins are left outside, strap down their lids (e.g., secure the lid with duct tape).
- Secure propane and other tanks and containers to limit spills and releases.
- Place barriers (e.g., sandbags) around structures to help divert debris and water.
- Remove dead or diseased trees and trim limbs away from buildings and water pipes to help prevent dislodged trees and branches and damage from flying vegetative debris.
- Cover and secure windows and doors (e.g., with protective shutters) to prevent damage from flying debris and reduce the risk of water damage.
- Use fire-safe landscaping and fire-resistant building materials (e.g., metal roofs and stucco) to reduce damage from fire.

Planning for resiliency should include determining locations of essential facilities, including hospitals, senior homes, childcare facilities, shelters, major and alternate transportation routes and infrastructure, including public transit, areas that may experience significant damage (such as developed areas within a floodplain), and facilities that manage or store large quantities of harmful chemicals, biological hazards (e.g., research laboratories), or hazardous waste. Knowing these locations in advance can help a community prioritize its preparatory and response activities. In addition, understanding where sensitive zones, such as floodplains, are located and reducing and/or avoiding development in such zones can potentially reduce impacts on emergency services, as well as reduce the overall amount of damage and debris caused by a natural disaster.

Many tools and resources exist to help communities plan, including:

- #HurricaneStrong (a partnership among FEMA, NOAA, and the Federal Alliance for Safe Homes (FLASH) to prevent hurricane damage to homes through hurricane safety and mitigation information) (<http://www.flash.org/hurricanestrong/>);
- CAMEO (Computer-aided Management of Emergency Operations) Chemicals (a tool to assist with hazardous material incident response and planning) (<https://cameochemicals.noaa.gov/>);
- Climate Change and the Electricity Sector: Guide for Climate Change Resilience Planning (September 2016) (https://energy.gov/sites/prod/files/2016/10/f33/Climate%20Change%20and%20the%20Electricity%20Sector%20Guide%20for%20Climate%20Change%20Resilience%20Planning%20September%202016_0.pdf);
- Disaster Debris Recovery Database for EPA Region 5 (<https://www.epa.gov/large-scale-residential-demolition/disaster-debris-recovery-database>);
- Flood hazard maps (<https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>);
- Hazard mitigation planning (<https://www.fema.gov/hazard-mitigation-planning>), specifically FEMA's "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" document, published January 2013 (<https://www.fema.gov/media-library/assets/documents/30627>);
- Hazards U.S. Multi-Hazard (Hazus-MH) (<https://www.fema.gov/hazus>);
- Incident Waste Decision Support Tool (I-WASTE) (registration required) (<http://www2.ergweb.com/bdrtool/login.asp>);
- Materials Management Wizard (MWiz) (provides a repository of EPA-sourced materials management tools and resources to support and promote sustainable materials management and community planning) (<https://www.epa.gov/sustainability/mwiz>);
- National Mitigation Framework (addresses how the whole community will develop, employ, and coordinate mitigation capabilities to reduce loss of life and property by lessening the impact of disasters) (<https://www.fema.gov/media-library/assets/documents/32209>);
- National Stormwater Calculator (<https://www.epa.gov/water-research/national-stormwater-calculator>); and
- U.S. Climate Resilience Toolkit (<https://toolkit.climate.gov/>).

Appendix A contains additional tools and resources.

In addition to debris management planning, communities should review their regulations to increase resiliency. Provisions in building codes, zoning, and land use regulations can help reduce the damage caused by natural disasters. Communities can find information on building-related resources, including design criteria, new technologies, and building codes, on the U.S. Army Corps of Engineers' (USACE's) Building Resilience website at <http://www.usace.army.mil/Missions/Sustainability/Building-Resilience/>. This information can be used to influence the adoption of new, alternative codes at the local or state level or to strengthen existing,

prevailing codes. Also, communities can adopt regulations like steep slope ordinances to prevent soil erosion, lessen the likelihood of landslides, and reduce the amount of debris produced if a landslide does occur. New land use and building ordinances can also be drafted to restrict construction in volcanic areas and floodplains to protect life and property and reduce disaster debris. Undeveloped land in coastal wetland areas can act as a buffer against storm surges. In addition to restoring or preserving natural barriers to storm surges, like wetlands, coastal communities can also construct barriers to absorb the force of storm surges created by hurricanes.

Conservation and infrastructure projects can also enhance a community's resiliency. Use of porous pavement and green spaces within a city, including vegetation along the edges of streets, help mitigate stress to the city's drainage systems and reduce water pollution. They help absorb water during instances of flooding and intense rain. Additionally, larger green spaces, such as parks or wildlife reserves, can be used as storm-surge buffers in coastal areas.

Environmental engineering projects that change a river or stream channel to break up the energy of rapidly moving water during extreme events and prevent overflow will likely raise the flood level upstream, creating a backwater, and will likely require a hydraulic analysis to be submitted to FEMA for approval prior to construction. Other permits under the Clean Water Act or local programs will likely be required for construction to modify a river or stream channel. Examples of environmental engineering projects include positioning rocks along the edges of rivers and streams and constructing drop structures in the stream bed to slow water flow and stabilize the river or stream channel. Increasing the elevation of islands, low-lying areas, and buildings can also mitigate water damage in the event of an extreme weather event. Before undertaking any environmental engineering project, communities should obtain necessary approvals or permits (e.g., a Clean Water Act section 404 permit), if applicable, and comply with all relevant federal, state, local, and tribal regulations and requirements, including local floodplain regulations and FEMA minimum floodplain standards. More information about FEMA's National Flood Insurance Program can be found at <https://www.fema.gov/national-flood-insurance-program>.

Building Resiliency to Flooding in Boulder, Colorado

Extensive damage caused by the Big Thompson Flood in 1976, as well as later flash floods in nearby canyons, provided the impetus for the City of Boulder to adopt a series of urban flood planning strategies. Engineering the river by placing jagged rocks and drop structures to direct force inwards and stabilize the river channel helped disrupt the energy of floodwater. Hinged, breakaway bridges were implemented to reduce damage and blockages from debris. These bridges were designed to detach at one end and swing open to disperse floodwater force without becoming a source of large, dangerous debris or a location for other debris to build up into a blockade. Boulder also constructed concrete bike paths that include gates that lock down to create a sealed channel for floodwater diversion, providing emergency containment for overflow from the river. Boulder also completed land use planning activities, including moving critical facilities, such as gas stations and water

treatment facilities, away from floodplains. Since the 1960s, the surrounding county has also accumulated 48,000 acres of land; this undeveloped, flood-prone land acts as a buffer against flood damage. All of the measures taken to reduce flood damage have greatly improved community resiliency and significantly lessened the damage Boulder experienced during the floods in September 2013.

Communities that are prone to wildfires, especially those with forested areas, should consider taking precautions like creating firebreaks, thinning densely packed small-diameter trees, and slashing brush and shrubs to remove potential fuel. Prescribed burns can also be utilized to consume any build-up of dead, damaged, or dry vegetation in a controlled manner to prevent the development of large, uncontrolled wildfires that could put the community at risk. Communities impacted by fire may be more vulnerable to mud and rockslides due to soil erosion for up to two years after a fire. Steeper areas, areas near water drainage routes, and areas that experience heavy rainfall are especially vulnerable to mud and rockslides. These slides may cause the movement of sediment, rocks, and debris generated by the fire, such as downed trees. In addition to regulatory mitigation techniques like steep slope ordinances, revegetation and vertical mulching after a fire can help.

2.1.2 Incorporate Climate Change Adaptation into Debris Management Planning

With climate change expected to increase the frequency and intensity of some natural disasters (http://s3.amazonaws.com/nca2014/low/NCA3_Climate_Change_Impacts_in_the_United%20States_LowRes.pdf?download=1), many communities are going beyond resilience to anticipate, plan, and prepare for the impacts of extreme weather events. The disaster debris-related consequences of major natural disasters may include:

- Larger quantities of debris resulting from the disaster;
- Wider variety of generated debris at one time, including atypical wastes in greater quantities;
- Wider area of impact, possibly affecting more than one jurisdiction;
- Insufficient debris management capacity to handle surges in necessary recycling, treatment, and disposal of debris;
- Greater chances of debris management facilities being impacted by the disaster, resulting in a possible decrease in existing capacity for generated debris and reduction of available debris management options;
- Greater risk of releases from facilities and sites that store chemicals (e.g., industrial facilities, underground storage tank sites) and contaminated sites (e.g., Superfund sites, brownfields); and
- Increased greenhouse gas emissions from debris management activities, such as the transportation, treatment, and disposal of large amounts of debris.

Planners who use EPA's recommended four-step planning process can incorporate climate change adaptation strategies into the process.

- Assuming the worst-case scenario: Under a changing climate, multiple events have already affected some communities. Planners should anticipate a combination of impacts (e.g., floods and fires), each of which may be intensified because of changing climatic conditions.
- Team formation: Including climate change officers and sustainability managers who are familiar with assessments of climate change vulnerability and projected climate change impacts can help planners establish worst-case scenarios.
- Reviewing existing plans: The jurisdiction's climate change adaptation plan, if available, will indicate where projected climate change impacts may contribute to future disasters. For example, by reviewing climate change adaptation plans, planners can better prepare for how debris management sites and facilities may be affected. Traditional locations that have served as staging, storage, treatment, and disposal sites may not be available or may lose capacity and integrity due to the impacts of a changing climate.
- Collaborating with neighboring jurisdictions: Debris management officials should consider working with neighboring jurisdictions to share climate change adaptation information and develop possible mutual aid agreements during planning. For example, a group of jurisdictions that share significant vulnerabilities, such as coastal flooding and storm surge, may benefit from sharing information about more secure debris management sites.
- Enhancing community resiliency: Planners should address the debris-related challenges resulting from climate change, such as increased quantities and types of debris, to increase their communities' resilience to projected climate change impacts. For example, planners should select alternate debris management facilities that are located away from floodplains and other at-risk areas and identify transportation routes that avoid low-lying areas.

Such planning activities should inform the development of the pre-incident debris management plan. Appendix A contains tools and resources on community resiliency and planning, as well as other topics, that planners may find helpful.

2.1.3 Determine Applicable Environmental Regulations and Requirements

Before a disaster, communities should understand how all debris types must be managed according to federal, state, local, and tribal regulations and permits. Once a disaster strikes, there will not be time to do extensive research. An effective debris management plan includes a catalog of all applicable waste management-related regulations, requirements, issues, and considerations. The plan should also include a contact list of pertinent federal, state, local, and tribal environmental officials to whom a community could reach out in the event that guidance on regulations is needed during cleanup. This list should also include contacts beyond environmental officials, such as officials representing transportation, emergency response, public health, public works, agricultural, and zoning agencies, as well as FEMA and USACE. Contacts

for EPA's regional offices and state environmental agencies can be found on EPA's website at <https://www.epa.gov/aboutepa> and <https://www.epa.gov/hwgenerators/links-hazardous-waste-programs-and-us-state-environmental-agencies>, respectively. Section 2.2.2 highlights several relevant waste management requirements and considerations.

2.1.4 Identify Available Resources

The planner should identify and review applicable national, regional, state, local, tribal, territorial, and organization-specific emergency programs, plans, and mutual aid agreements, including those of bordering jurisdictions (e.g., neighboring countries), as these may be a source of helpful and pertinent information and resources.

Mutual Aid Agreements and Other Local Resources

The Emergency Planning and Community Right-to-Know Act (EPCRA), which includes emergency planning and community right-to-know requirements, establishes emergency planning committees. Many local and tribal communities have a Local Emergency Planning Committee (LEPC) or Tribal Emergency Planning Committee (TEPC), respectively. Generally, the purposes of these emergency planning committees are: development, training, and testing of the hazardous substances emergency response plan for the community; development of procedures for regulated facilities to provide information and emergency notification to the emergency planning committee; development of procedures for receiving and processing requests from the public under EPCRA; and public notification of LEPC and TEPC activities. A major role for these emergency planning committees is to work with industry and the interested public to encourage each local stakeholder to pay continuous attention to chemical safety, risk reduction, and accident prevention and provide information about chemicals in the community to citizens. To be prepared for a hazardous material incident in a community, the LEPC and TEPC usually coordinates with community officials, first responders, and industrial representatives to develop a detailed emergency plan to ensure public safety. Communities can contact their State Emergency Response Commission (SERC) or Tribal Emergency Response Commission (TERC) to find their LEPC or TEPC (<https://www.epa.gov/epcra/local-emergency-planning-committees>).

Communities can enter into mutual aid agreements with neighboring foreign, state, local, and tribal governments prior to any natural disaster. Such an agreement could provide for either binding commitments or nonbinding intentions of support to assist one another in the event of a natural disaster. Through these agreements, communities can borrow equipment, personnel with specific expertise or experience, or land for temporary debris management sites.

An example of a mutual aid agreement between states is the Emergency Management Assistance Compact (EMAC). Established in 1996, EMAC is a congressionally ratified agreement that establishes a national system that facilitates the transfer of personnel, equipment, commodities, and services across state lines during an emergency or disaster. After its governor declares an emergency or disaster, a disaster-impacted state can request and receive assistance from other member states quickly and efficiently through EMAC, resolving the key

issues of liability and reimbursement upfront. The assisting states send the requested resources. After the cleanup is underway and the requesting state returns to normal operations, the assisting states request reimbursement of costs. More information on EMAC can be found at <https://www.emacweb.org/>.

Mutual aid agreements and resource sharing may be beneficial to tribes whose lands are interspersed with non-tribally owned land due to the General Allotment Act of 1887. The resultant checkerboard pattern of ownership and jurisdiction on many tribal lands can further complicate disaster response efforts. Tribes may want to consider entering into agreements with neighboring jurisdictions and non-tribal landowners to share resources and complement their waste management efforts.

Another possible source of information and assistance may be from the administering organization of the watershed to which a community belongs. A watershed is an area, typically within a state, consisting of multiple jurisdictions that have a common waste management system. These local jurisdictions may collaborate, addressing issues affecting their shared waste management system at a regional level.

Information Sharing

One of the best ways to prepare for disasters is to learn from other communities' experiences and planning. Section 3 of this document contains lessons learned from past disaster responses and case studies. Section 4 lists examples of state, city, and county debris management plans and guidance. These case studies and plans are just a few examples; many more are available than are captured in this document. For example, other sources of best practices and lessons learned from previous natural disasters may be available from the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) (<http://astswmo.org/>) and the Solid Waste Association of North America (SWANA) (<http://community.swana.org/search?executeSearch=true&SearchTerm=disaster+management&l=1>). In addition, planners should consider:

- Checking with other communities that have experienced a disaster to learn about environmental and legal issues that may have delayed the management of disaster debris;
- Partnering with similar communities that have prepared or are currently preparing for natural disasters, whether in the same state or elsewhere;
- Developing an information-sharing mechanism with these communities, which may include meetings and site visits;
- Negotiating an agreement, if practicable, with these communities to share staffing and equipment resources in the event of a natural disaster; and
- Having additional experienced personnel that already understand the debris management plan to aid in post-disaster cleanup.

State Resources

State emergency management and environmental agencies have specific roles to play in managing disaster debris. Their websites may contain useful debris management information, including state-specific guidelines and requirements, planning documents, and material on past disaster responses. The state emergency management agency serves as the local government's liaison to FEMA during the disaster and cleanup. The state environmental agency can make special accommodations for the extraordinary debris management needs resulting from a natural disaster. State emergency management and environmental agencies can issue emergency management orders to help local governments better manage debris in order to protect human health and the environment. The National Emergency Management Association can provide state emergency management agency contacts (<https://www.nemaweb.org/>). ASTSWMO represents state and territorial solid waste regulators and can provide appropriate contacts and information (<http://astswmo.org/state-and-territorial-resources/>).

Private Sector Resources

Serious natural disasters may quickly overwhelm community resources. In these circumstances, communities will likely need to hire private disaster debris management contractors. Often, such contractors are experienced in dealing with disaster recovery work, such as establishing staging areas, hauling and segregating debris, and coordinating FEMA reimbursement processes. It would be beneficial for local officials to identify what disaster debris management contractors are in their area prior to a natural disaster. As part of disaster planning, planners should pre-negotiate contracts to save time and resources during a response. More information on contracting can be found in the Equipment and Staffing Needs section below.

Other private companies and local businesses may be able to offer assistance at reasonable rates. Consider checking with local companies, preferably before a disaster to ensure availability, to see if they could offer specific assistance, such as allowing large parking lots to be converted into debris staging areas or community drop-off locations. Waste management facilities and transfer stations might be available to serve also as debris management sites. Construction companies might be able to make earth-moving equipment, water pumps, and other necessary equipment available for immediate use in the event of a disaster. Trucking companies might be able to lend trailers, dump trucks, or roll-off dumpsters to help with response efforts. Recyclers might be able to send mobile processing equipment

Working with Private Companies

Dell Computer and Best Buy partnered with EPA, states, and local governments to increase collection and safe recycling of computers and related electronic equipment, including monitors, printers, scanners, keyboards, mice, laptops, TVs, VCRs, DVD players, radios, and disks damaged by Hurricane Katrina. More than 220,000 pounds of e-waste were recycled.

(e.g., portable crushing plants) to the disaster area. These opportunities are just a few examples of how a community can work with the private sector in the event of a disaster.

Federal Resources

Federal assistance supplements state, local, and tribal resources during situations where those resources have been or will be overwhelmed. The legal authority for federal assistance in natural disasters comes from the Robert T. Stafford Disaster Relief and Emergency Assistance Act (hereafter referred to as the “Stafford Act”), which sets forth federal disaster relief responsibilities, procedures, and conditions for federal assistance. Among many other activities, the Stafford Act authorizes debris removal in “the public interest . . . from publicly and privately owned lands and water.” In order to receive federal assistance under the Stafford Act, the governor of a state or the Chief Executive of a federally recognized tribal government requests an emergency or major disaster declaration. The President makes the final decision to declare an emergency or major disaster for an area, making the area eligible for federal assistance. Federal assistance may include funding (i.e., Public Assistance, Individual Assistance, and Hazard Mitigation Assistance) and direct federal assistance (i.e., the work is accomplished by a federal agency). The federal assistance available depends on the type of declaration that is declared. The disaster declaration process is described in further detail at <https://www.fema.gov/disaster-declaration-process>. Information specific to tribal declarations can be found at <https://www.fema.gov/tribal-declarations-pilot-guidance>.

The U.S. Department of Homeland Security (DHS) developed the National Response Framework (NRF) to provide a guide on how the U.S. responds to all types of disasters and emergencies, and it includes a description of federal support mechanisms for disaster response (<https://www.fema.gov/media-library/assets/documents/32230>). The NRF categorizes the capabilities of federal departments and agencies into fourteen Emergency Support Functions (ESFs) (see Figure 3 below) to provide the planning, support, resources, program implementation, and emergency services that are most likely to be needed for incidents requiring a coordinated federal response (<https://www.fema.gov/media-library/assets/documents/25512>). Different federal agencies coordinate the various ESFs. The ESF coordinator is the entity with management oversight for that particular ESF. The coordinator has ongoing responsibilities throughout the preparedness, response, and short-term recovery phases of incident management. The ESFs that address natural disaster debris removal are ESF #3, “Public Works and Engineering,” and ESF #10, “Oil and Hazardous Materials Response.” DHS makes a final determination as to whether to activate each ESF; not all ESFs are necessarily activated in response to all disasters.

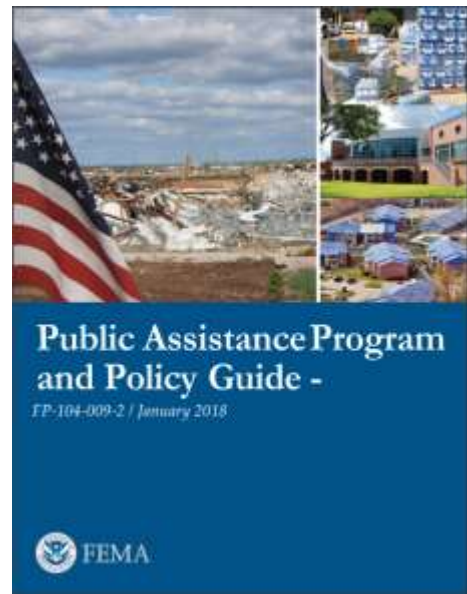
Figure 3. Emergency Support Functions (ESFs) Listed in the National Response Framework

ESF #	Function	ESF Coordinator
1	Transportation	U.S. Department of Transportation
2	Communications	U.S. Department of Homeland Security (National Protection and Programs Directorate/ Office of Cybersecurity and Communications)
3	Public Works and Engineering	U.S. Department of Defense (U.S. Army Corps of Engineers)
4	Firefighting	U.S. Department of Agriculture (U.S. Forest Service) and U.S. Department of Homeland Security (Federal Emergency Management Agency/U.S. Fire Administration)
5	Information and Planning	U.S. Department of Homeland Security (Federal Emergency Management Agency)
6	Mass Care, Emergency Assistance, Temporary Housing, and Human Services	U.S. Department of Homeland Security (Federal Emergency Management Agency)
7	Logistics	U.S. General Services Administration and U.S. Department of Homeland Security (Federal Emergency Management Agency)
8	Public Health and Medical Services	U.S. Department of Health and Human Services
9	Search and Rescue	U.S. Department of Homeland Security (Federal Emergency Management Agency)
10	Oil and Hazardous Materials Response	U.S. Environmental Protection Agency
11	Agriculture and Natural Resources	U.S. Department of Agriculture
12	Energy	U.S. Department of Energy
13	Public Safety and Security	U.S. Department of Justice (Bureau of Alcohol, Tobacco, Firearms and Explosives)
14	Superseded by the National Disaster Recovery Framework	
15	External Affairs	U.S. Department of Homeland Security

For the recovery process, DHS developed the National Disaster Recovery Framework, which can be found at <https://www.fema.gov/national-disaster-recovery-framework>. This framework provides information on how the whole community builds, sustains, and coordinates delivery of recovery capabilities. It encourages communities to prepare for recovery before a disaster occurs.

Federal Emergency Management Agency (FEMA)

FEMA is the lead federal agency that responds to disasters and emergencies to help save lives and protect public health, safety, and property. An important resource for state, territorial, tribal, and local governments is FEMA's Public Assistance (PA) Program. In January 2018, FEMA published the third version of the "Public Assistance Program and Policy Guide (PAPPG)," which discusses the PA Program and details the eligibility criteria for PA funding (see <https://www.fema.gov/media-library/assets/documents/111781>). Debris removal activities, including clearance, removal, and disposal, may be eligible for PA funding "if the removal is in the public interest based on whether the work:



- Eliminates immediate threats to lives, public health, and safety;
- Eliminates immediate threats of significant damage to improved public or private property;
- Ensures economic recovery of the affected community to the benefit of the community at large; or
- Mitigates risk to life and property by removing Substantially Damaged structures and associated structures and appurtenances as needed to convert property acquired using [Hazard Mitigation Grant Program] funds to uses compatible with open space, recreation, or wetlands management practices." (footnotes omitted)

In the PAPPG, FEMA also describes a pilot program for alternative procedures for debris removal. These alternative procedures may be available for the following:

- Increased Federal cost share based on a sliding scale linked to the accelerated completion of debris removal;
- Reimbursement of straight-time for force account labor;
- Retention of income generated from recycling debris; and
- A one-time 2 percent increased cost-share incentive for a FEMA-accepted debris management plan with pre-qualified debris removal contractors before the start of the incident period.

Through the pilot program, FEMA encourages and provides incentives for recycling debris. More information about FEMA's alternative procedures can be found at <http://www.fema.gov/alternative-procedures>.

Understanding FEMA's PA requirements prior to an emergency may enable a community to recover the maximum allowable funding for cleanup costs. While not all disaster recovery efforts will qualify for federal funding from FEMA, a debris management plan should meet FEMA's requirements in case the disaster is severe enough to qualify for federal funding (see Appendix D: Debris Management Plan Job Aid in the PAPPG). FEMA's Emergency Management Institute (EMI) provides a broad variety of emergency management training to federal, state, local, and tribal government officials, volunteer organizations, and the public and private sectors. Training is offered on debris management planning (e.g., E202: Debris Management Planning for State, Tribal, and Local Officials), debris operations under FEMA's PA Program (e.g., IS-632.A: Introduction to Debris Operations), hazardous materials (e.g., IS-5.A: An Introduction to Hazardous Materials), the NRF (e.g., IS-800.B: National Response Framework, An Introduction), and related topics. A complete listing of EMI's training courses can be found at <http://training.fema.gov>.

FEMA also provides pre-disaster hazard mitigation grants to mitigate the risk from natural disasters even if no presidential emergency or major disaster declaration is made. For example, under Section 203 of the Stafford Act, pre-disaster mitigation assistance is available. Under the National Flood Insurance Act (NFIA), 42 USC 4104c, FEMA provides flood mitigation assistance. Under Section 20602 of the Bipartisan Budget Act of 2018, wildfire mitigation assistance may be provided; however, assistance under Section 420 of the Stafford Act (Fire Management Assistance) must have been provided to the area. For more information on FEMA's hazard mitigation funding programs, please visit FEMA's Hazard Mitigation Assistance website at <https://www.fema.gov/hazard-mitigation-assistance>.

U.S. Army Corps of Engineers (USACE)

USACE is a public engineering organization that operates within the U.S. Department of Defense. Under the NRF, USACE is the coordinator and primary agency for ESF #3, "Public Works and Engineering." USACE also plays key roles in support of FEMA and other federal agencies. Typical USACE activities and mission assignments include providing emergency power, establishing temporary shelters and housing, providing temporary roofs, assessing building structural safety, emergency repair of public infrastructure, providing safe drinking water, and performing debris removal and disposal operations.

USACE maintains seven Debris Planning and Response Teams and ten regional and sub-regional contracts for debris operations, all dedicated to supporting state, local, tribal, and territorial governments. Under the NRF, USACE provides assistance to state, local, tribal, and territorial governments through Direct Federal Assistance mission assignments. USACE provides expert advice on all aspects of debris management and helps state, local, tribal, and territorial governments perform their own debris operations. Direct Federal Assistance is provided at the request of the state, local, tribal, or territorial government when the scope of work is beyond

the capacity of the government to perform. USACE uses its teams and contracts to perform the debris operations mission in partnership with the state, local, tribal, or territorial government. Additional information can be found on the USACE's website (<http://www.usace.army.mil/>).

USACE Support

The USACE response to Hurricanes Dennis, Katrina, Rita, and Wilma in 2005 illustrates the type of support USACE provides the nation under ESF #3 in support of FEMA:

- A total of 6,141 USACE employees supported the response to the hurricanes.
- The total amount of FEMA's mission assignments to USACE was \$4.4 billion.
- USACE installed a total of 193,000 temporary roofs.
- USACE delivered 27 million gallons of water and 232 million pounds of ice.
- USACE conducted 2,406 generator pre-installation inspections and then installed 914 generators.
- USACE removed a total of 38,967,195 cubic yards of debris.

U.S. Environmental Protection Agency (EPA)

EPA is the lead federal agency under ESF #10, "Oil and Hazardous Materials Response." Under this ESF, EPA can manage orphaned tanks (for propane and other fuel), drums, white goods, and household hazardous waste (HHW). EPA can also provide support to state, local, tribal, and territorial agencies in properly managing debris deemed hazardous, including HHW. EPA is also a support agency to USACE under ESF #3, "Public Works and Engineering." EPA can assist USACE and state, local, tribal, and territorial agencies in identifying disposal sites for debris. In addition, EPA can assist with contaminated debris management activities by coordinating and/or providing resources, assessments, data, expertise, technical assistance, and monitoring.

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, and the National Contingency Plan (NCP), as amended, EPA may be able to provide support even when disasters are not federally declared. Under CERCLA, EPA has authority to respond to the release or threatened release into the environment of hazardous substances, as well as pollutants or contaminants that may present an imminent and substantial danger to the public health or welfare.

Additionally, EPA can assist in identifying potentially impacted facilities, such as industrial facilities or Superfund sites, which may require unique debris management approaches. EPA responders may deploy during a response to a natural disaster and undertake preliminary damage assessments in the impacted communities. EPA can use data it receives under its various emergency management programs to identify and locate certain facilities that use and store hazardous substances or oil. EPA maintains a GIS-based tool, Enforcement and

Compliance History Online (ECHO), to locate facilities by city, state, and/or region (<https://echo.epa.gov/>).

EPA Involvement in Hurricane Katrina

EPA worked with USACE and other federal agencies, state agencies, and local governments to facilitate the collection, segregation, and management of HHW. EPA provided extensive outreach and technical assistance on topics such as identifying and disposing of electrical equipment that may contain PCBs and handling and disposing of debris containing asbestos. EPA also set up monitoring stations to monitor air and water quality following Hurricane Katrina. Additionally, EPA provided the affected states with technical assistance on the management of white goods, as well as on management options for quarantined debris. A summary of this assistance can be found at <https://archive.epa.gov/katrina/web/html/>.

U.S. Coast Guard (USCG)

USCG is the primary agency for ESF #10 actions when the incident affects the coastal zone. Under ESF #10, the USCG provides support in response to actual or potential discharges and/or releases of oil or hazardous materials in the coastal zone. (EPA is the primary agency for these responses in inland zones or when the incident affects both the inland and coastal zones.) Also, under ESF #3, the USCG marks and coordinates with USACE for the removal of obstructions declared to be hazards to navigation, assists in vessel salvage and removal of vessel debris, and oversees oil and hazardous substance pollution response operations associated with debris removal and salvage operations in the coastal zone in accordance with the NCP (40 CFR Part 300).

U.S. Department of Agriculture (USDA)

The USDA provides leadership, technical expertise, and assistance for food, agriculture, natural resources, rural development, and nutrition. In support of these areas, USDA created an online Disaster Resource Center (<http://www.usda.gov/wps/portal/usda/usdahome?navid=disaster-help>) with a searchable database containing disaster-related resources. This website also includes information on USDA disaster assistance programs for farmers, ranchers, and communities, such as the Emergency Conservation Program, Emergency Watershed Protection Program, Emergency Loan Program, and Emergency Assistance for Livestock, Honeybees, and Farm-Raised Fish. Under the Emergency Conservation Program, funding may be available for farmers and ranchers to rehabilitate farmland damaged by natural disasters. The purpose of the Emergency Watershed Protection Program is to provide funding to owners, managers, and users of public, private, or tribal lands in the event that a natural disaster damaged their watershed area. The Emergency Loan Program helps farmers and ranchers recover from production and physical losses due to natural disasters or quarantine with emergency loans. Emergency Assistance for Livestock, Honeybees, and Farm-Raised Fish provides emergency

assistance for eligible livestock losses due to disease and natural disasters. These programs are just a sampling of the assistance programs offered by USDA for disasters.

As a coordinator and primary agency for ESF #11, “Agriculture and Natural Resources,” USDA may also provide assistance through the NRF. Under this ESF, the USDA coordinates response activities for nutrition assistance, economically devastating outbreaks of plant pest or disease, and ensuring the safety and security of the commercial food supply. USDA also supports USACE under ESF #3, “Public Works and Engineering,” by providing engineering and contracting/procurement personnel and equipment to assist in emergency removal of debris (which may include animal carcasses).

Federal Highway Administration (FHWA)

The U.S. Department of Transportation’s (DOT’s) FHWA administers the Federal-aid Highway Emergency Relief Program. Through this program, FHWA assists in the repair of federal roads that have suffered serious, widespread damage because of natural disasters. More information on this program can be found at <http://www.fhwa.dot.gov/programadmin/erelief.cfm>.

The FHWA also administers the Emergency Relief for Federally Owned Roads Program, which assists federal agencies with the repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel. These transportations facilities and federally owned roads must have suffered serious, widespread damage by a natural disaster or catastrophic failure. Instructions on how federal agencies and tribal governments can apply for this funding are found in the program’s manual, which can be found at <https://flh.fhwa.dot.gov/programs/erfo/>.

U.S. Department of Housing and Urban Development (HUD)

When funding is available, HUD awards Community Development Block Grant Disaster Recovery grants to help communities recover from presidentially declared disasters. Awards are typically made to states or local governments, as authorized by Congress. The grants may fund a broad range of activities related to disaster relief, long-term recovery, and restoration of infrastructure, housing, and economic revitalization. For eligibility requirements and other information, visit <https://www.hudexchange.info/programs/cdbg-dr/>. Also, HUD created a Disaster Response Toolkit to aid homeowners and property owners in the disaster recovery process. This toolkit includes guidance on how to rehabilitate flooded homes, design and construction practices that promote moisture resistance and durability, and preparedness for future disasters. It is available at <https://www.huduser.gov/portal/disaster-recovery.html>.

National Oceanic and Atmospheric Administration (NOAA)

NOAA, an agency within the Department of Commerce, administers the MDP. Under this program, NOAA has a separate statutory authority and mandate regarding natural disaster debris, specifically marine debris. Relevant MDP functions authorized under the Marine Debris Act include:

- the responsibility to “identify, determine sources of, assess, prevent, reduce, and remove marine debris, with a focus on marine debris posing a threat to living marine resources, and navigation safety” (33 USC 1952(b)(1));
- undertaking outreach and education activities for the public and other stakeholders regarding marine debris and its adverse impacts, which support emergency response outreach and planning (33 USC 1952(b)(4)); and
- developing “interagency plans for the timely response to events determined by the [NOAA] Administrator to be severe marine debris events, including plans to coordinate across agencies and with relevant State, tribal, and local governments to ensure adequate, timely, and efficient response” (33 USC 1952(b)(5)).

The NOAA MDP offers Community-based Marine Debris Removal Grants that support locally driven, community-based marine debris prevention and removal projects. More information can be found at <https://marinedebris.noaa.gov/about-us/funding>.

2.2 Develop a Comprehensive Pre-incident Debris Management Plan

2.2.1 Consider Using EPA’s Suggested Debris Management Plan Outline

Communities should document their planning in a pre-incident debris management plan, which is Step 2 in EPA’s recommended pre-incident planning process. EPA has created a waste management plan outline that can be used to prepare for natural disasters. This outline provides a suggested template for a scalable, adaptable pre-incident plan. The specific contents and organization of a pre-incident plan are flexible. The outline in Figure 4 provides an example to help emergency planners and managers get started. Appendix B contains the full list of suggested content for a typical pre-incident plan and identifies potential issues, resources, and tips to help with plan development. Please consult this appendix for more in-depth information that should be considered when developing each section of the plan to maximize its benefit during an actual incident.

Figure 4. Suggested Pre-incident Debris Management Plan Outline

- I. Plan Overview
 1. Scope
 2. Planning assumptions
 3. List of officials who should be notified in the case of an incident
 4. Roles and responsibilities
 5. Regulatory requirements
 6. Record of plan reviews and updates to include any changes made
- II. Materials and Debris Streams
 1. List of anticipated debris streams
 2. Description of each debris stream
- III. Debris Quantities
 1. Forecast quantity of each type of anticipated debris stream
 2. Method for estimating actual debris quantities during/after a disaster
- IV. Waste Characterization Sampling and Analysis
 1. Sampling
 2. Analysis
 3. Quality assurance
- V. Debris Management Strategies/Options
 1. General principles
 - a. Minimization
 - b. Collection
 - c. Segregation
 - d. Decontamination
 - e. Accumulation/Storage
 2. Pre-selected debris management sites
 - a. Debris staging and storage (short-term and long-term) locations
 - b. Equipment staging and storage (short-term and long-term) locations
 - c. Decontamination and treatment stations
- VI. Waste Management Facilities
 1. Anticipated types of waste management facilities needed
 2. Specific facilities identified
- VII. Transportation
 1. Logistical options
 2. Routes (including maps)
 3. Hauler information

- VIII. Debris and Material Tracking and Reporting System
 1. General principles
 2. Databases or other tracking software to be used
 3. Debris tracking report templates

- IX. Community Communications/Outreach Plan
 1. Contact information for key stakeholder groups
 2. Pre-scripted information for waste management activities involving the public
 3. Information for a response website once a disaster occurs

- X. Health and Safety for Debris Management Activities

- XI. Resource Summary
 1. Resource needs
 2. Resource sources
 - a. Mutual Aid Agreements
 - b. Pre-negotiated contracts
 - c. Specialized experts
 3. Specialized technical assistance contacts
 4. Contracting
 - a. Emergency procurement procedures
 - b. Contract oversight plan
 5. Cost accounting/financial management
 6. FEMA eligibility guidance

RECOMMENDED APPENDICES

- Job Aids for debris management staff positions
- List of training classes available for different debris management roles
- Pre-written debris management emergency ordinances, orders, directives, declarations, designations, permits, etc.
- Maps of waste management facilities and sites, transportation routes, critical waste management infrastructure, and key resources
- Links to health and safety information
- Protective Action Guides
- Glossary and list of acronyms

2.2.2 Identify Debris Types and Forecast Amounts

Possible Material and Waste Streams

Planners should assess the types of materials and wastes that will likely make up disaster debris based on the characteristics and features of their communities. For example, planners in communities with large industrial and commercial areas should plan for different debris streams and volumes of debris than planners in agricultural and rural communities. Communities with

industries and commercial enterprises should coordinate with these businesses regarding debris management. Communities with older housing stock may need to pay special attention to the potential presence of asbestos-containing material (ACM), PCB-containing waste, mercury-containing devices, such as thermostats, and lead-based paint. Also, some types of debris result more frequently from certain types of natural disasters. For example, planners on the Atlantic and Gulf Coasts faced with responding to hurricanes, which generate vegetative debris, C&D debris, building contents, animal carcasses, and displaced soils and sediments, likely need to plan for different debris streams and volumes than planners in the West who are more often confronted with earthquakes and wildfires, which generate asphalt, C&D debris, and building contents.

Generally, natural disaster debris can include:

- ACM (e.g., asbestos pipe wrap, siding, and ceiling and floor tiles);
- Ammunition and explosives;
- Animal carcasses;
- Asphalt;
- Building contents (e.g., furniture, personal property);
- Commingled debris (i.e., a mixture of many debris types, such as C&D debris, vegetative debris, HHW, and building contents);
- C&D debris (e.g., mixed metals, masonry materials, concrete, lumber, asphalt shingles);
- Cylinders and tanks;
- Electronics waste (e-waste) (e.g., televisions, computers, cell phones);
- Food waste (e.g., rotten food from grocery stores, restaurants, and residences);
- Hazardous waste (e.g., batteries, pesticides, solvents, paint thinners, mercury-containing devices);
- HHW (e.g., household cleaners, freezer and refrigerator coolant);
- Marine or waterway debris;
- Medical waste;
- Metals;
- Mixed waste (i.e., waste containing both radioactive and hazardous waste components);
- Municipal solid waste (MSW);
- PCB-containing waste (e.g., transformers, capacitors, other electrical equipment);
- Pharmaceuticals;
- Radiological-contaminated waste (e.g., hospital equipment);
- Soils, sediments, and sandbags;
- Tires;
- Treated wood (e.g., utility poles, fencing, decks);
- Used oil and oil-contaminated waste;
- Vegetative debris (or green waste) (e.g., uprooted trees, branches, stumps, leaves);
- Vehicles and vessels; and
- White goods (i.e., household appliances, such as stoves, refrigerators, washers/dryers, air conditioner units).

Waste Management Requirements and Considerations

Planners should open a dialogue with regulators (e.g., EPA regional office) as early as possible to discuss potential debris generation and debris management options. EPA has developed I-WASTE, a web-based tool that contains links to waste transportation guidance, treatment and disposal facilities, state regulatory offices, packaging guidance, and guidance to minimize the potential for contaminating treatment or disposal facilities. Access to this decision support tool requires pre-registration (<http://www2.epa.gov/bdrtool/login.asp>).

Resource Conservation and Recovery Act (RCRA) – Disaster Debris

Most debris generated is likely regulated under RCRA. Under RCRA, EPA issues regulations and guidelines to manage hazardous (Subtitle C) and nonhazardous (Subtitle D) solid wastes properly. EPA also provides support and technical assistance to state and local governments on how these wastes can be best managed. The RCRA regulations generally define a waste as hazardous if it: 1) is a listed waste (40 CFR §§ 261.31-261.33), or 2) exhibits specific characteristics (40 CFR §§ 261.21-261.24). States (except for Alaska and Iowa) have the primary responsibility to implement the hazardous waste regulations and play the lead role in implementing nonhazardous waste programs (minimum federal guidelines in 40 CFR §§ 257 and 258). States can impose more stringent requirements than the federal program.

All hazardous and nonhazardous solid wastes should be managed in accordance with applicable federal, state, local, and tribal regulations. For example, all regulated hazardous wastes should be managed in appropriate hazardous waste treatment or disposal facilities that comply with federal, state, local, and tribal regulations. Also, hazardous wastes and other hazardous materials are subject to DOT's Hazardous Materials Regulations (49 CFR parts 171-180), which impose requirements related to classification, hazard communication, packaging, and training. For more information on the federal regulations that apply to hazardous waste management, please visit <https://www.epa.gov/hw>. In addition, to support the implementation of RCRA, EPA manages an extensive database that documents EPA's interpretations of the RCRA regulations. The RCRA Online database is available on EPA's website at <https://www.epa.gov/rcra>. Links to state solid and hazardous waste programs and environmental agencies can be found at <https://www.epa.gov/hwgenerators/links-hazardous-waste-programs-and-us-state-environmental-agencies>.

National Emissions Standards for Hazardous Air Pollutants (NESHAP) – ACM

RCRA is not the only statute that may apply to natural disaster debris. Planners should be aware that there are regulations that govern the removal and management of ACM that may be found in structures (e.g., in attic and wall insulation, ceiling and floor tiles, roofing and siding shingles) affected by a natural disaster. These regulations may affect the demolition and deconstruction of buildings and subsequent debris removal. Planners should consider, as part of their planning activities, how to handle such situations and how to advise the public. To the extent that demolition or renovation activities are necessary in connection with any such facility, the requirements of the federal asbestos regulations under NESHAP may be applicable

(40 CFR part 61, Subpart M). Also, in some instances, individual states have promulgated their own asbestos regulations and are authorized to take the lead in implementing and enforcing them. EPA published “Guidance for Catastrophic Emergency Situations Involving Asbestos” in December 2009, which discusses federal asbestos regulations, the types of asbestos issues that may arise during catastrophic events, and how EPA has addressed such issues (<https://www.epa.gov/large-scale-residential-demolition/guidance-catastrophic-emergency-situations-involving-asbestos>). This document includes information on:

- Exposure concerns for emergency responders and others in the immediate area;
- Cleanup and disposal of debris that may be contaminated with asbestos;
- Demolition and renovation of buildings during recovery efforts; and
- Transport and disposal of material that may contain asbestos.

As described in NESHAP, regulated ACM must be removed prior to demolition under the supervision of a person trained in accordance with the regulations. The material must be adequately wetted throughout the process and disposed of properly, which may include labeling, transportation requirements, tracking the waste, recordkeeping, and disposal in a landfill that meets specific NESHAP requirements. No wastes suspected to contain asbestos should be ground or incinerated at debris management sites (see 40 CFR § 61.145(c)(10)). For information on state-specific asbestos regulations, contact the state. Many MSW and C&D landfills have handling procedures for wastes suspected to contain asbestos. Contact the state or landfill for guidance.

To the extent that an entity is dealing with debris from structures already demolished by a natural disaster (as opposed to human demolition), the requirements of the asbestos NESHAP (or the state equivalent) may not be applicable. If there is any question as to the applicability of the asbestos regulations, contact and coordinate with the appropriate federal, state, and local authorities. Additional information, including EPA and state contacts, can be found at <https://www.epa.gov/asbestos>. Planners should also be aware that in past disaster recovery efforts, communities were able to secure No Action Assurance (NAA) letters from EPA that allow for more regulatory flexibility in removing damaged structures that may contain asbestos in times of extreme hardship, although the issuance of NAA letters happens only in extremely unusual situations. These NAA letters allowed the demolition of entire structures without first removing asbestos, but the entire structure must then be managed as ACM. Planners should assess the possibility of hardship due to the amount of ACM that could be generated by a natural disaster in their area and determine the steps that would be needed to request an NAA letter. More information about NAA letters and when they may be issued can be found in EPA’s “Guidance for Catastrophic Emergency Situations Involving Asbestos” at <https://www.epa.gov/large-scale-residential-demolition/guidance-catastrophic-emergency-situations-involving-asbestos>.

Toxic Substances Control Act (TSCA) – PCBs

PCB-containing waste is subject to cleanup and disposal in accordance with the Toxic Substances Control Act (TSCA) regulations in 40 CFR part 761. To answer questions regarding

the assessment, cleanup, and disposal of PCBs during and immediately after an emergency situation caused by a natural disaster, EPA published guidance on “Planning for Polychlorinated Biphenyl-Containing Disaster Debris” in June 2011

(<https://www.epa.gov/homeland-security-waste/guidance-about-planning-polychlorinated-biphenyl-containing-disaster-debris>).

Debris management personnel should notify the local

electric utility if a downed utility pole is encountered. If a transformer appears to be leaking and does not have a sticker declaring that it is PCB-free, personnel should immediately notify the regional EPA office and the electric utility, as well as restrict public access to the area using temporary fencing or barrier tape. In the absence of identifying information, responders should assume a transformer contains PCBs. More information about the management of PCB-containing waste can be found at <https://www.epa.gov/pcbs>. This website lists facilities that can store and dispose of PCB wastes.



PCB Guidance for Hurricane Harvey and Hurricane Irma

Recently, EPA Regions 6 and 4 issued guidance documents providing flexibility in the cleanup and disposal of certain PCB-containing disaster waste generated during Hurricane Harvey and Hurricane Irma, respectively, under emergency response and similar provisions of the TSCA PCB regulations. Each document was developed specifically for the particular hurricane in each region and did not apply more broadly or in other contexts. These documents primarily provided for the cleanup and disposal of covered waste based on the PCB concentration of the materials on which PCBs were spilled (the as-found concentration), rather than the PCB concentration of the spilled material (source concentration), in specific circumstances when it would have been difficult to determine the source concentration. This flexibility was intended to allow for a more expeditious response to cleanup and disposal of covered PCB-containing disaster waste in order to mitigate exposures and potential risks from PCB spills.

Special Handling and Management for Specific Debris Streams

Other debris streams may require special handling and management too. For example, while many appropriate management options, including reuse and recycling options, exist for C&D debris, a small percentage of this debris contains constituents of potential concern that can be

harmful to human health and the environment if improperly managed (e.g., lead, mercury). A non-exhaustive list of harmful materials that may be found in debris from residential property can be found on EPA's website at <https://www.epa.gov/large-scale-residential-demolition/harmful-materials-and-residential-demolition>. For many of these constituents, protective federal regulations or guidance are in place to prevent or restrict the use of the material or to recommend best management practices. A party managing C&D debris with federally regulated constituents must meet the requirements and standards of all applicable federal regulations. Many states and local governments have also established their own requirements for harmful constituents in C&D debris.

Drywall (also known as sheetrock or wallboard) is an example of a C&D material that should be managed with certain considerations in mind. Most C&D drywall generated in a disaster will likely be managed through disposal in a landfill. Disposal of drywall in landfills can generate significant emissions under certain landfill conditions. Drywall contains a gypsum core sandwiched between two sheets of paper. Under the anaerobic conditions that exist in landfills and in the presence of moisture, drywall decomposition has been shown to generate hydrogen sulfide (H₂S) gas. H₂S may pose an odor problem and, in very large concentrations, may pose a health risk to landfill workers and nearby residents. In response to significant H₂S emissions in a Warren, Ohio landfill, which caused a Superfund action, EPA issued a report in August 2014 on *Best Management Practices to Prevent and Control Hydrogen Sulfide and Reduced Sulfur Compound Emissions at Landfills That Dispose of Gypsum Drywall*. This report provides regulatory agencies, landfill owners and operators, and other interested parties with scientific information around H₂S issues at landfill sites and recommends best management practices to limit H₂S emissions. For more information and to ensure proper management when C&D drywall cannot be recycled, please see EPA's report on best management practices for drywall at <https://nepis.epa.gov/Adobe/PDF/P100NG53.pdf>.

Another example of a problematic debris stream is ammunition and explosives. Collection and management of ammunition and explosives should be done in coordination with state and local law enforcement, and these items should be transported as required by federal hazardous materials transportation law. Prompt collection of this waste stream can be important to ensure the safety of the



public.

White goods containing

refrigerants, food, and other putrescible wastes may require special handling and management as well.

Before these appliances can be managed, the refrigerants and putrescible wastes should be removed and managed in a safe and proper manner.

Also, above ground and underground storage tanks could potentially release petroleum or hazardous



substances that pose significant risk to health, safety, and the environment. Storage tanks should always be addressed with care. If, for example, gasoline pumps or vent pipes are present near a damaged building or if an unknown tank or cylinder is discovered, debris collection activities should be stopped, the area sealed off, and the state environmental agency should be contacted for assistance. Additional information can be found at <https://www.epa.gov/ust>.

Formosan termites, Ash Borers, and other pests may restrict the shipment of vegetative debris to other geographical areas. Therefore, vegetative debris should be monitored for signs of pests. Planners should consult with their state agricultural departments for guidance on pests of concern within their geographical area.

Debris Forecasting

Before a natural disaster occurs, planners should forecast the amount of debris that different types and sizes of natural disasters may generate to understand the possible scope and scale of debris cleanup efforts. These estimates can be based on previous experience or can be made using forecasting tools and should consider potential debris runoff from upland/upstream, depending on the geography and topography of the community. Past disasters in other areas can also give planners an idea of the quantities and types of debris that are likely to be generated. Due to the unpredictable nature of natural disasters, planners will not be able to obtain completely accurate numbers from forecasting tools or past experience. However, knowing possible ranges of debris that may be generated provides planners with valuable information that can help them determine their waste management needs, including number of waste management sites and facilities, equipment, and personnel. A description of debris management activities from recent disasters is presented in Section 3.

FEMA's Hazus-MH program is a nationally applicable standardized methodology and software program that estimates potential losses from earthquakes, hurricanes, and floods. Hazus-MH uses state-of-the-art Geographic Information System (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of earthquakes, hurricane winds, and floods on populations. Planners can find more information and instructions for downloading the latest version of Hazus-MH for free by visiting <https://www.fema.gov/hazus>.

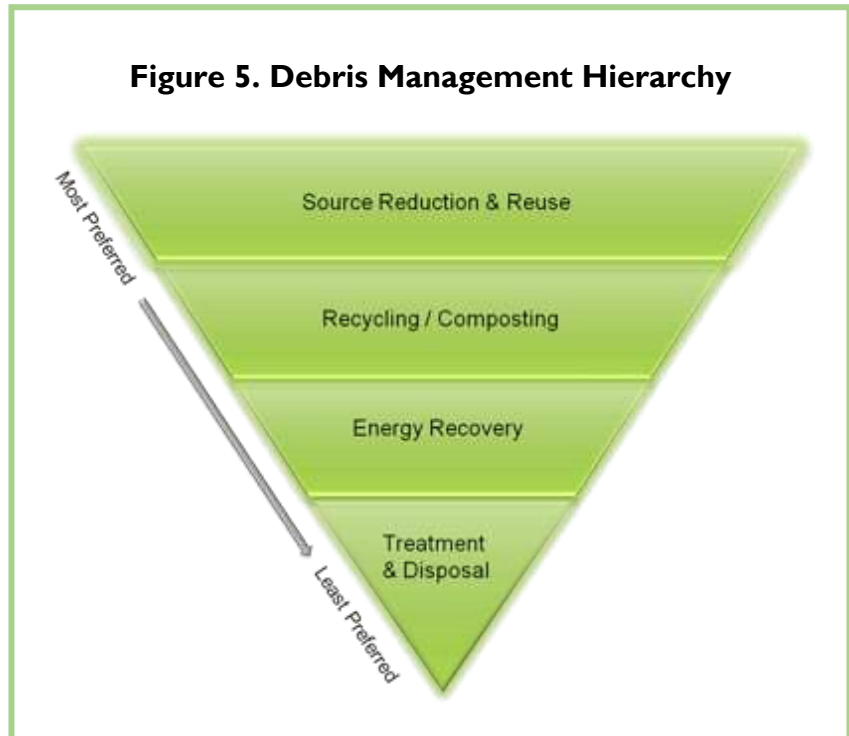
USACE develops Disaster Impact Models for hurricanes about to make landfall that planners can use to narrow their hurricane debris estimates. USACE uses geospatial tools to provide estimates of possible debris volumes, number of people and households likely to be impacted by hurricane force winds, and possible temporary roofing and housing needs about three days prior to a forecasted hurricane landfall. The model results of current and past storms can be found on USACE's website (<http://www.usace.army.mil/Missions/Emergency-Operations/Disaster-Impact-Models/>).

EPA also developed a debris estimator for natural disasters. As part of I-WASTE, EPA provides a Waste Materials Estimator that can generate order of magnitude estimates for the types and quantities of materials that may require decontamination and/or disposal. This tool can

generate waste estimates for open spaces and various structures. Estimates can be based on default parameter or user-specified values. This tool can be accessed at <http://www2.ergweb.com/bdrtool/login.asp>.

2.2.3 Evaluate Debris Management Options

EPA has developed a recommended four-tiered hierarchy (see Figure 5) to guide waste management decision-making. Prior planning for potential disasters should include identifying opportunities for source reduction and waste minimization. However, once disaster debris has been generated, communities should be prepared to manage it. For any disaster, an important goal of debris management should be to reduce the amount of disposable waste and preserve valuable, limited landfill space. Being prepared will help officials manage debris in an environmentally responsible



manner by ensuring that: 1) debris segregation is optimized; 2) storage or staging sites are located in acceptable areas; 3) reuse and recycling opportunities are utilized to the fullest extent possible; 4) hazardous wastes and other problematic waste streams (e.g., ACM, PCB-containing wastes) are properly managed; 5) available landfill capacity is used appropriately; and 6) new debris management units or closed units that are reopened have appropriate siting restrictions and controls in place.

After the amounts and types of debris are forecasted, planners should assess the area's capacity to manage the anticipated debris. Waste management facilities, including reuse, recycling, combustion, and disposal facilities, should be inventoried, along with their daily and overall capacities for each debris stream they are permitted to receive. Each facility's ability to manage additional debris beyond their normal or permitted daily load should be evaluated. Planners are encouraged to check the compliance histories of potential facilities with their state, local, or tribal officials or use EPA's Enforcement and Compliance History Online (ECHO) national database to search compliance and enforcement information for regulated facilities (<https://echo.epa.gov/>). Communities generally should avoid sending disaster debris to facilities with poor compliance histories to the maximum extent feasible, even if it reduces available capacity within the area, to prevent potential problems in the future.

If there is not sufficient capacity to manage the predicted amount of debris in the immediate area, waste management facilities in neighboring communities, states, or regions should also be identified. EPA recommends that contacts for all waste management facilities be listed for quick reference along with the facilities' physical locations, including latitude and longitude coordinates, Global Positioning System (GPS) coordinates, and/or road maps. Lists of any other necessary service providers (e.g., demolition contractors, refrigerant removers), as well as their compliance histories, should also be compiled.

To help planners determine debris management options, I-WASTE provides a searchable list of treatment and disposal facilities, which was largely compiled using data from EPA and publically available sources, a downloadable KMZ file with the same geolocated facilities suitable for incorporation into GIS visualization and analysis, and useful resources on recycling various materials. The facilities contained within I-WASTE include:

- MSW landfills;
- C&D landfills;
- Hazardous waste landfills;
- MSW combustion facilities;
- Hazardous waste combustion facilities;
- Medical waste incinerators;
- Wood-fired boilers; and
- Electric arc furnaces.

In addition, information and locations for 12 types of recyclers and landfills (over 6,000 facilities) in and surrounding EPA Region 5 (IL, IN, MI, MN, OH, WI) that are capable of managing different debris streams can be found in EPA's Disaster Debris Recovery Database, which is available at <https://www.epa.gov/large-scale-residential-demolition/disaster-debris-recovery-database>. Also, EPA provides state-by-state contact information about programs that relate to large-scale residential demolition to help determine appropriate management options in each state (<https://www.epa.gov/large-scale-residential-demolition/state-demolition-information#main-content>).

Options available for each debris stream should be documented in a pre-incident debris management plan. All information (e.g., capacity, capability, contact information, hours of operation) should be verified with each facility to ensure the most current, updated information is included in the plan. While I-WASTE does not direct the user on how or where to manage debris, it allows facilities to be searched by type and location. Anyone interested in accessing this online tool may request a user name and password at <http://www2.ergweb.com/bdrtool/login.asp>.

Transportation needs are also very important to consider. When planning, communities should consider how far debris management sites and facilities are from the impacted area, how debris could be transported to them, and what regulations may apply (e.g., RCRA, DOT, state-specific). A community should evaluate different options for moving debris to preferred facilities and consider all forms of transportation, including rail and barge. Rail and barge are

high-capacity options that may significantly ease the logistics of moving large volumes of debris but may not be conveniently located to either the debris field or the debris management site or facility. Trucks may be able to travel more easily to sites and facilities but many trucks may be needed to handle large debris volumes, crowding roads and communities. Planners should consider that major transportation routes and traditional access routes might be damaged or blocked by debris; alternative and backup routes, as well as sites and facilities, should be identified. The U.S. Department of Energy's (DOE's) Transportation Routing Analysis Geographic Information System (TRAGIS) can be consulted to determine transportation routes (<https://webtragis.ornl.gov/tragis/app/login>).



Reuse and Recycling

Considerations for Reuse and Recycling

Many of the materials generated by natural disasters are recyclable and can be utilized. EPA recommends that debris management plans include strategies for recovering debris for reuse and recycling. Planning for reuse and recycling before a disaster occurs, including creating a segregation strategy and finding recyclers who are able to accept debris, increases the likelihood that debris would be reused and recycled during a disaster response. Due to the large volumes of debris produced by natural disasters, reuse and recycling can be effective tools to lessen the burden on disposal facilities, save landfill space, and reduce recovery effort costs. Recycling also conserves natural resources by replacing them with recovered products that perform similar functions and reduces greenhouse gas emissions. Furthermore, under FEMA's Alternative Procedures Pilot Program, communities may retain revenue received through recycling without an offset to the award amount if used for an approved purpose (<https://www.fema.gov/media-library/assets/documents/111781>).

In addition to potential environmental and economic benefits, reuse and recycling may provide cultural benefits. If historic resources, especially historic districts with a high concentration of cultural resources in one area, are impacted by a natural disaster, communities should put controls in place to segregate out debris that is historic in nature and could possibly be reused or recycled. The *Secretary of the Interior's Standards for the Treatment of Historic Properties* and associated guidelines for preserving, rehabilitating, restoring, and reconstructing historic buildings provide a framework and guidance for decision-making about work or changes to a historic property. These standards, in part, call for the preservation of distinctive materials,

features, finishes, and construction techniques or examples of craftsmanship that characterize a property. For more information, please visit <https://www.nps.gov/tps/standards.htm>.

When considering debris reuse and recycling, disaster plans should include criteria and different options for each debris stream, priorities for reuse and recycling, necessary contracts, and possible markets for recycled debris. Communities should consult FEMA on these priorities during the planning stage before a disaster to help ensure reimbursement.

Communities with a pre-established reuse and recycling program can take advantage of their existing networks (e.g., materials recovery facility (MRF)). Additionally, communities can expand current recycling practices before a disaster rather than attempting to design and implement new policies during a disaster response. Having a pre-existing recycling infrastructure removes many of the permitting, compliance, collection, processing, marketing, and contracting difficulties that communities face in a post-disaster situation. While implementing reuse and recycling plans is easier if a community can rely on infrastructure that is already in place, communities without robust recycling programs can still create new reuse and recycling opportunities during a disaster. All potential recyclers should be verified before debris is sent to them to make sure the debris is being legitimately and responsibly recycled. EPA developed a two-page guide to help generators of secondary hazardous materials choose a responsible recycler, the basic principles of which may be applicable to other debris streams (<https://www.epa.gov/hwgenerators/choosing-responsible-recycler-guide-generators-secondary-hazardous-materials>). In addition, EPA's website contains information on finding responsible recyclers of certain white goods (i.e., refrigerated appliances, such as refrigerators, freezers, window air-conditioning units, and dehumidifiers) (<https://www.epa.gov/rad/find-rad-partner-programs>) and electronics (<https://www.epa.gov/smm-electronics/certified-electronics-recyclers>).

Communities should also consider available reuse and recycling opportunities in other states, regions, and countries. While transporting materials long distances may increase cost and environmental impact (e.g., the further a material must be moved, the more fuel will be burned to move it there), these potential disadvantages should be balanced against other factors, including limited capacity available at disposal facilities and long-term environmental consequences (e.g., depleting natural resources). Provisions may be needed to store the material for an extended period of time before recycling can occur. For some materials (e.g., HHW), however, regulations may restrict how long such materials can be stored. Planners should check with state environmental officials for possible restrictions.

In addition, planners should check with state officials and recycling facilities to determine any applicable requirements pertaining to the reuse and recycling of debris streams, such as vegetative debris, building materials, and e-waste. Communities should confirm with recycling facilities their acceptance criteria (e.g., condition, size) for debris and discuss under what circumstances debris is no longer suitable for recycling. These circumstances may vary by debris stream, disaster, and individual facility. For example, e-waste that has been damaged by floodwaters might be accepted by recyclers if the items are clean (e.g., no mud or mold) and dried. Reuse and recycling opportunities for clean (i.e., not treated or painted) wood, however,

may be limited if it has been in a flood. Even if dried, the wood might no longer be structurally sound or aesthetically appropriate for reuse or recycling in some applications (e.g., reuse in structural elements) but may be fine in other applications (e.g., as an interior finish material) or as boiler fuel. Metal that has been in floodwaters would likely still be able to be recycled as scrap metal. In searching for markets for disaster debris, communities should contact recyclers of scrap metal, white goods, vegetative debris, concrete, asphalt, and electronics, among others, before a disaster occurs to determine what they would accept. If possible, communities should pre-negotiate contracts with them. Planners should identify in the debris management plan where different debris streams may be sent for recycling, how to process the material according to market specifications, what equipment is needed to process the debris, and if any contracts are in place.

Health and safety requirements should also be considered when handling debris for reuse, recycling, or other purposes. Some debris may contain constituents that can be harmful to human health and the environment. Federal, state, local, and tribal requirements and policies may be applicable to these harmful constituents. For example, ACM, PCBs, and lead-based paint may be found in a portion of C&D debris. Management of this debris must meet the requirements and standards of all applicable regulations. Precautions should be taken by waste handlers, transporters, and facilities to protect human health and the environment (e.g., monitor debris to identify and segregate harmful materials). For examples of potentially harmful constituents that may be found in residential disaster debris and their management considerations, please see EPA's Harmful Materials and Residential Demolition webpage at <https://www.epa.gov/large-scale-residential-demolition/harmful-materials-and-residential-demolition>.

Reuse and Recycling by Debris Stream

C&D DEBRIS

When controls are in place to segregate out debris that is inappropriate for reuse and recycling (e.g., ACM), various materials in the C&D debris stream can be successfully managed into new productive uses. In some cases, they can be reused as is, while in others they might first be resized, refinished, or reprocessed. For example, concrete can be broken up for use as aggregate in roads and bridges, bricks can be cleaned up for reuse, metals can be screened out for recycling, and organic materials, such as wood, can be reprocessed into compost or mulch. Furthermore, in accordance with the RCRA non-hazardous secondary material (NHSM) regulations, processed C&D wood that has been managed under best management practices and meets legitimacy criteria prior to burning may be able to be burned as fuel for energy (see the Waste-to-Energy section below). The environmentally responsible reuse and recycling of C&D



Source: FEMA/Suzanne Everson

debris conserves raw materials, offsets environmental impacts of the extraction and production processes needed for new materials, reduces landfilling impacts, and conserves landfill space.

- **Asphalt and Asphalt Shingles:** Chunks of asphalt from damaged roads and asphalt shingles from roofing can be crushed and reused as new asphalt pavement mixes. Asphalt shingles can also serve two purposes at a cement kiln: combustion of the shingles provides energy in the kiln and the remaining mineral components containing the limestone granules serve as a raw material for cement. Information about recycling asphalt can be found on the Asphalt Recycling & Reclaiming Association's website at <http://www.arra.org/>. More information on recycling asphalt shingles can be found at <http://www.shinglerecycling.org>.
- **Concrete and Masonry Materials:** Heavy masonry materials, such as bricks and blocks, and concrete can be crushed into an aggregate and reused as a base for new roads, added to concrete mix, and used for pipe bedding, soil stabilization, and various other landscaping purposes. Depending on its quality and condition, brick, unlike concrete, can be simply reused. For example, decorative brick that is recovered undamaged holds significant aesthetic appeal and can be reused in interior decorative portions of buildings or small-scale repairs. See USACE's Public Works Technical Bulletin 200-1-44 on *Recycling Exterior Building Finish Materials* for more information at <http://wbdg.org/ffc/army-coe/public-works-technical-bulletins-pwtb/pwtb-200-1-44>. Additional information about recycling concrete can be found on the Construction & Demolition Recycling Association's (CDRA's) website at <https://cdrecycling.org/materials/concrete/>.
- **Gypsum Drywall:** Although drywall is typically landfilled, reuse and recycling opportunities for drywall potentially exist. Depending on state, local, and tribal regulations, gypsum can be removed for reuse in new drywall, cement production, and fertilizer production. In addition, gypsum can be used to improve soil drainage and facilitate composting; however, the composting system must be kept aerobic to prevent the production of H₂S. State, local, and tribal agencies should be consulted to determine the regulations and requirements that must be met for gypsum recycling. Information about recycling gypsum drywall can be found on CDRA's website at <https://cdrecycling.org/materials/gypsum-drywall/>.
- **Mixed Metals:** Metal can almost always be reclaimed from C&D metal products, and such reclamation opportunities are available across the country. More information can be found on the Institute of Scrap Recycling Industries' website (<http://www.isri.org>) or the Steel Recycling Institute's website (<http://www.recycle-steel.org>).
- **Other C&D Debris:** Other types of C&D debris can be reused and recycled as well. Information about reuse and recycling of C&D debris can be found on EPA's website at <https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials>. The Construction Industry Compliance Assistance Center provides additional compliance information (<http://www.cicacenter.org>). Further information, including lists

of C&D debris recyclers and reuse stores, can be found on CDRA's website (<http://www.cdrecycling.org/>), on the Building Materials Reuse Association's (BMRA's) website (<https://bmra.org/>), and in the Whole Building Design Guide's Construction Waste Management Database (<http://www.wbdg.org/additional-resources/tools/construction-waste-management-database>). Communities should also contact their state or local environmental protection agencies for more information on C&D debris recycling.

E-WASTE

E-waste can be generated by any type of natural disaster and includes televisions, desktop and laptop computers, computer attachments, stereo equipment, tablets, cell phones, and other electronic devices. Used electronics have special handling needs and should be managed separately from waste going to MRFs.

Moreover, many states and territories have mandatory take back requirements and/or landfill bans on used electronics. Computer monitors and older TV picture tubes using cathode ray tube (CRT) technology contain an average of four pounds of lead and may require special handling in accordance with state regulations, although the prevalence of CRTs is much lower than it was previously. As technology advances, the composition of electronics continues to change. For example, many lead-containing CRTs have been replaced with flat-screen televisions that may have backlighting that contains mercury. In addition to lead and mercury, electronics can contain lithium-ion batteries, chromium, cadmium, beryllium, nickel, zinc, and brominated flame retardants that should be handled and managed properly.



Many organizations accept electronics for reuse. If electronics are too damaged to be repaired, some of their parts might still be reusable. EPA encourages the use of electronics recyclers that have been certified to the Responsible Recycling Standard for Electronics Recyclers (R2)

(<https://sustainableelectronics.org/>) or to the e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment (e-Stewards) (<http://e-stewards.org/>).

Communities can search for electronics recyclers that have been certified to one of the electronics recycling programs at <https://sustainableelectronics.org/recyclers> and <http://e-stewards.org/find-a-recycler/>.

PUTRESCIBLE WASTE

Putrescible wastes including food and animal carcasses rot quickly, depending on temperature and precipitation. If they are not managed quickly, they can decay to the point where they become difficult to handle, begin leaching into surface or floodwaters, and attract disease vectors. Because of the time constraints and potential risks to human health and the environment, removal of putrescible waste should be prioritized by responders. Rapid management of these wastes is especially important in areas with large livestock ranches or poultry farms, which may have large amounts of animal carcasses after a disaster, and in areas with high temperatures, which can speed decomposition. Other major sources of putrescible waste include grocery stores, restaurants, schools, hospitals, and residences.

Putrescible wastes may be able to be composted, rendered, digested, or treated through alkaline hydrolysis. Each of these options reduces debris volume and creates a potentially useful product. However, existing facilities may not be able to handle large volumes of debris, especially with regard to animal carcasses, and may not accept all types of putrescible wastes. Planners should contact facilities before a disaster to determine their capacity and capabilities. Food and animal carcasses should be managed separately.

- **Composting:** Composting can be very cost-effective because it has low starting costs and generates a reusable end product, such as fertilizer. Composting animal carcasses may be more difficult than traditional food and organic waste composting and is most effective when composting operations are overseen by a trained subject matter expert. Carcasses may take 3-6 months to decompose completely, and some states may have legal restrictions on composting animal carcasses. Also, composting requires a carbon source (e.g., wood chips), which may present logistical challenges in the aftermath of a disaster. To find a composter, visit <http://www.findacomposter.com/>. Animal carcasses may be composted on-site in accordance with best management practices.
- **Rendering:** Rendering is the process of separating fats and proteins through the application of heat. Rendering yields ingredients that are used in soaps, paints, cosmetics, explosives, leather, pharmaceuticals, textiles, and lubricants. Rendering is an effective treatment method for animal carcasses with high fat contents, such as cattle and swine. More information on rendering can be found on the National Renderers Association's website at <http://www.nationalrenderers.org/>. Some food, such as meat products, may be rendered as well (<https://www.epa.gov/sustainable-management-food/industrial-uses-wasted-food>).
- **Digestion:** Digestion involves a process that uses bacteria to break down organic matter, such as food and animal carcasses. Aerobic digestion is a contained system that converts organic material to humus with oxygen. Anaerobic digestion happens in closed spaces where there is no air (or oxygen), producing biosolids and methane gas, which are potentially useful products. Information on anaerobic digestion can be found at <https://www.epa.gov/anaerobic-digestion>. Anaerobic digestion sites can be searched on <http://www.findacomposter.com/>.

- **Alkaline hydrolysis:** In this process, an alkaline solution, such as sodium hydroxide, is applied along with pressure and heat to animal carcasses to convert them into an aqueous solution. The remaining bone residue can be utilized as sterile bone meal. The rest of the carcass, which is sterilized by the process of alkaline hydrolysis, can then be composted.

For additional help on proper management of animal carcasses after a disaster, consult the state's agricultural department or USDA. The USDA provides leadership, technical expertise, and assistance for the management of animal carcasses. For example, see the USDA's website on Disaster Planning at <https://www.nal.usda.gov/awic/disaster-planning>.

SOILS, SEDIMENTS, AND SANDBAGS

Wind or water may displace large quantities of soil and sediment that may need to be removed as part of the cleanup. Also, communities may use sandbags to divert floodwaters away from structures, which would then need to be removed. Uncontaminated soils and sediments can be returned to their original location or used in temporary berms for future storm protection, as fill in reconstruction projects, or as cover material in landfills.

Unused sandbags may be reused in future disasters. Soils, sediments, and sandbags that are suspected to be contaminated should be tested and screened to remove other debris. Contamination may include sewage, bacteria



Source: FEMA/Crow Norlander

(e.g., *E. coli*), heavy metals (e.g., arsenic, lead), fuel oils, industrial chemicals, and agricultural chemicals (e.g., fertilizers, pesticides).



Source: FEMA/David Fine

States may have developed specific recommendations or requirements for managing contaminated soils, sediments, and sandbags. For example, some states may not allow sandbags that have been in contact with floodwaters to be reused. Also, check with the state regarding reuse of sands, sediments, and sandbags in playgrounds, beaches, sandboxes, and other areas where direct human contact is possible.

TREATED WOOD

Treated wood contains chemical preservatives that can contaminate recycled wood products. Therefore, treated wood should be managed separately from vegetative debris. Tools exist to find treated wood, such as an X-ray Fluorescence (XRF) Analyzer, so that treated wood can be segregated from other debris. Wooden utility poles, decks, fences, landscaping materials, wood

bridges, and railroad ties are all likely to be made out of treated wood. It can be combusted in waste-to-energy facilities, provided the facilities comply with existing federal, state, and local requirements. Treated wood should not be openly burned because this treatment would adversely impact air quality. However, the availability of different management options may depend on the type of treated wood (e.g., creosote-treated wood, Chromated Copper Arsenate (CCA)-treated wood). More information about CCA-treated wood can be found at <http://www.ccaresearch.org>.



Source: FEMA/Robert Kaufmann

VEGETATIVE DEBRIS

Clean vegetative debris has many beneficial uses. Therefore, care should be taken to segregate chemically treated lumber and painted wood (e.g., lead-based paint) from clean vegetative debris because these wood products may not be accepted by recyclers of clean vegetative debris. Whole trees, for example, can be de-limbed and used as a timber resource for sawmills, veneer or panel makers, furniture makers, and specialty wood companies, among others. Vegetative debris can also be recycled for use in pulp and paper mills, wood pellet mills, and engineered wood companies. Trees and other vegetative debris can also be ground or chipped for



Source: FEMA/Tim Burkitt

residential, commercial, and agricultural purposes. Other uses include composting, animal bedding, landfill cover, and boiler fuel. Planners may be able to identify large-scale landscaping opportunities for mulch, such as landscaping in parks and recreation areas and along roadsides or railways. Additional information on the management and potential end uses of vegetative debris is available from the U.S. Composting Council (<http://www.compostingcouncil.org>). Planners should determine if recyclers of vegetative debris would also accept clean C&D wood (e.g., clean wood framing) or if they are able to segregate vegetative debris from C&D wood.



Source: FEMA/FEMA News Photo

Also, planners may want to consider whether on-site composting (e.g., at a temporary debris management site) of vegetative and other debris is a viable option.

Pre-planning may be especially important for reuse of large stocks of vegetative debris (e.g., large wooded areas) as timing is usually key in moving these materials to appropriate markets. Also, pre-negotiated contracts may provide some revenue or cost-free labor for the community where recyclers are able to recover large amounts of clean vegetative debris.

The Federal Woody Biomass Utilization Group (WBUG), composed of technical specialists representing several federal agencies, encourages the use of vegetative debris and other woody biomass. They define woody biomass utilization as the harvest, sale, offer, trade, and/or use of woody biomass, resulting in the production of a full range of wood products, including timber, engineered lumber, paper and pulp, furniture and value-added commodities, as well as bio-energy and/or bio-based products, such as plastics, ethanol, and diesel. Using vegetative debris for these purposes instead of disposing of it provides numerous societal, economic, and environmental benefits, including improving air quality by reducing smoke from open burning, creating economic opportunities in the community, and providing renewable fuel for clean energy while saving landfill space. WBUG's website provides tools and resources on woody biomass and vegetative debris utilization, including success stories, at https://www.forestsandrangelands.gov/Woody_Biomass/index.shtml.

VEHICLES AND VESSELS

Before vehicles and vessels can be recycled, all motor fuels, oils, and other fluids should be drained and lead acid batteries, tires, gas tanks, airbags, small capacitors, and mercury switches should be removed and managed appropriately. The battery, catalytic converter, tires, and plastics can all be removed for reuse and recycling. Vehicles and vessels manufactured prior to 1979 may contain PCBs in the plastic or rubber components, wire or cable insulation, applied paints, varnishes, or coatings, and small capacitors. These vehicles and vessels should be tested for PCBs prior to recycling. If PCB-containing components cannot be removed and disposed of prior to recycling, the entire vehicle or vessel cannot be



Source: FEMA/Marilee Caliendo

recycled. Additionally, metals in the vehicle or vessel can be recycled as scrap metal. However, boats made from wood or fiberglass have more limited recycling opportunities, depending upon the location, market conditions, and access to more specialized recycling markets. Planning should take into consideration what local and regional recycling, reuse, or refurbishment

facilities can and will take. Since vehicles and vessels are usually private property, they may have title and ownership issues that must be resolved before they can be scrapped. More information can be found from the Automotive Recyclers Association (<http://www.a-r-a.org>).

WHITE GOODS

White goods can be recycled as scrap metal. Some appliances require special attention because they may contain putrescible wastes, refrigerants, and PCB-containing capacitors. Refrigerant-containing appliances, including refrigerators, freezers, and window air conditioning units, should be handled by EPA-certified technicians or recycling centers to prevent releases. Information about the safe disposal of refrigerant-containing appliances can be found at <https://www.epa.gov/section608>.



Source: FEMA/Adam DuBrowa

Waste-to-Energy

Depending on the types of debris present, natural disaster debris may be sent to a waste-to-energy facility. A waste-to-energy facility converts waste materials into usable heat, electricity, or fuel through combustion. Typical non-hazardous waste-to-energy facilities can handle many types of debris, including vegetative debris, C&D debris, furniture and other home contents, and putrescible wastes. Storage capacity may be necessary for this material as natural disasters often produce more material than a typical combustor can handle. Because emissions from these facilities are regulated under the Clean Air Act, contamination that could pose a problem to recycling and composting operations (such as treated wood) might not be a problem for waste-to-energy facilities equipped with adequate air pollution controls. Some waste-to-energy facilities require that the debris be ground prior to receiving it. Planners should contact facilities prior to a natural disaster to determine their acceptance criteria.

The RCRA NHSM regulations help identify which secondary materials (i.e., materials that can no longer serve the purposes for which they were produced) are wastes that must be burned in solid waste incineration facilities under Clean Air Act section 129 or materials that can be combusted as a product fuel in industrial boilers under Clean Air Act section 112. Under the NHSM standards, C&D wood processed from C&D debris according to specified best management practices would be considered as “categorical” non-waste fuels. Disaster debris consisting of trees and clean wood is designated as “traditional fuel” (similar to oil or natural gas), which can be burned in any type of combustion unit. For other debris materials, the 40 CFR part 241 standards outline self-implementing procedures that the generator or combustor can apply on a site-specific basis to determine their waste/non-waste status, as well as the provisions governing NHSMs categorically listed as non-waste fuels. For more information on how the NHSM regulations affect the management of disaster debris, please go to EPA’s website on the Identification of Non-Hazardous Secondary Materials That Are Solid Waste at <https://www.epa.gov/rcra/identification-non-hazardous-secondary-materials-are-solid-waste>.

The best management practices for processed C&D wood are described in Section V.A.3. of the preamble to the 2016 Additions to List of Categorical Non-Waste Fuels final rule (81 Fed. Reg. 6688, 6694; February 8, 2016) and governed by the regulations codified at 40 CFR 241.4(a)(5).

Identifying facilities that accept disaster debris as part of pre-incident planning can be mutually beneficial to all parties involved. Power plants or other types of combustors that are permitted to accept biomass (i.e., vegetative debris) or other disaster debris may exist near communities affected by disasters; in these cases, delivering the materials to power generators and combustors instead of landfills may require little extra effort or cost. One way to evaluate potential biomass markets is to involve the state forestry or natural resources agency. The Energy Recovery Council can also provide additional information and assistance locating waste-to-energy facilities for MSW (<http://energyrecoverycouncil.org/>). Another option is contacting the Council of Industrial Boiler Owners for information and assistance in locating an industrial boiler that can take biomass generated from a disaster (<https://www.cibo.org/>).

Biomass Successes

Florida – Approximately half of the vegetative debris, or about 800,000 cubic yards, generated by Hurricanes Charley, Frances, and Jeanne in Polk County were used to generate electricity by Progress Energy. County officials stated that this was both the most environmentally preferable and most cost-effective option. Similarly, after Hurricane Ivan, Escambia County exported about 60% of their vegetative debris to Italy for use as biomass fuel.

Louisiana and Mississippi – Green Energy Resources, a renewable energy company, bought one million tons of vegetative debris from Louisiana and Mississippi after Hurricane Katrina. The debris was sent to the United Kingdom to fulfill an annual contract. The company purchased an additional million tons of vegetative debris for use in American power plants.

Texas – American Biorefining, a local, alternative power company, salvaged millions of tons of trees, branches, and other vegetative debris left behind by Hurricane Rita. The vegetative debris was processed for use as biomass fuel and shipped to several European countries for use in power generation.

Treatment and Disposal

Once reuse, recycling, and waste-to-energy opportunities have been exhausted (or used to the maximum extent possible under the circumstances) for debris generated by natural disasters, the remaining debris should be treated and/or disposed of in a manner that protects human health and the environment. In general, most of the debris generated from natural disasters is not hazardous and can be managed, as appropriate, in a nonhazardous solid waste combustion

unit, C&D debris landfill, or MSW landfill that is in compliance with all applicable regulations. Some wastes (e.g., cylinders and tanks or their contents) may have to be managed in a hazardous waste combustion unit and/or landfill.

Communities should evaluate existing treatment and disposal capacity for all debris streams and plan on using existing waste management facilities before considering other disposal options. The use of an existing, properly permitted waste management facility should always be considered appropriate because existing facilities have been designed with adequate controls, as previously determined by state permitting or other agencies. Waste management facilities typically have acceptance criteria, siting criteria, operational requirements, design standards, environmental monitoring, and closure/post-closure standards that help ensure protection of human health and the environment. State solid waste management agencies may require waste management facilities to, for example, minimize odors and disease vectors, have runoff controls, provide daily cover, limit access to the public, and provide for adequate setbacks.

In the event that existing waste management facilities do not have the capacity or capability to manage all disaster-generated debris, including those in other communities that are accessible by rail, barge, or truck, planners should consider storing debris long-term, reopening a closed facility, or constructing a new facility. Long-term storage of debris may be necessary until other management options become feasible, including reopening or constructing a waste management facility. Storage is the holding of waste for a temporary period of time prior to its treatment or disposal. Federal, state, local, tribal, and territorial laws and regulations, such as obtaining necessary permits, may apply. Reopening a closed facility may be preferable to siting a new facility if the closed waste management facility is capable of being re-opened and operated in a manner that is protective of human health and the environment. Constructing a new waste management facility may be necessary if reopening closed waste management facilities is not an option due to distance or insufficient environmental protections. However, this option may be extremely difficult to implement due to community concerns and legal requirements. New waste management facilities should be sited in areas with favorable hydrogeological conditions and comply with applicable operational requirements. They should not be sited in certain locations, such as floodplains, wetlands, and areas in close proximity to drinking water. Identifying appropriate areas in advance allows time for any necessary environmental assessments required by state or local environmental agencies. Environmental assessment and monitoring may be necessary before, during, and after debris is placed in any of these locations.

Open burning, which includes both burning debris in an open pit and using an air curtain incinerator (ACI), may be another option. The air curtain burning method incorporates a pit constructed by digging below grade or building above grade (if there is a shallow groundwater table) and a blower. The blower and pit make up an engineered system that must be precisely configured to function properly. The blower must have adequate air velocity to provide a "curtain effect" to contain the smoke and to feed air to the fire below. The pit configuration must have a precise width, depth, and length to complement the blower. Some incinerators are portable and utilize a pre-manufactured pit in lieu of an on-site constructed earth/limestone pit. Portable ACIs are the most efficient burning systems available due to the pre-manufactured pit, which is engineered to precise dimensions to complement the blower system. Pre-

manufactured pits require little to no maintenance compared to earth or stone constructed pits, which are susceptible to erosion and sluffing. Portable ACI units are more suitable for areas with shallow groundwater tables, sandy soils, and where opacity (smoke) must be kept to a minimum.

Open burning often is subject to significant public concern. State, local, and tribal officials may allow it if storage or staging sites are insufficient and debris amounts are large. However, open burning is not permissible in many places. Therefore, check with appropriate authorities to determine whether it is a viable option for debris. All open burning should be conducted in accordance with relevant regulations. Open burning shall not violate applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the Administrator pursuant to section 110 under the Clean Air Act. Best practices should be used in open burning to protect human health and the environment. Typically, only vegetative debris is burned in an open pit, while both vegetative debris and segregated clean building material may be burned in an ACI. Treated and painted wood should be removed from the waste stream before open burning. Similarly, no materials suspected to contain asbestos (see 40 CFR § 61.145(c)(10)) or lead should be burned at debris management sites. Communities can contact and coordinate with the appropriate tribal, local, state, and federal authorities if there is any question as to the applicability of the asbestos NESHAP (or the state-equivalent regulation) if ACM is suspected to be present.

2.2.4 Establish Debris Management Needs and Strategies

Debris removal should begin as soon as it is safe for trained debris management personnel to be out in the community. A community should be prepared with a plan for removing debris from land, waterways, and sensitive habitats, such as shorelines, wetlands, and marshes, before a disaster occurs. Due to limited resources available for debris removal activities, these activities should be prioritized. One initial debris removal activity will likely be clearing roadways to ensure that emergency vehicles can travel effectively and make vital infrastructure like hospitals accessible. Following the initial clearing, the debris removal strategy should discuss how each type of debris would be segregated, collected, and managed. Debris that may pose an immediate threat to human health and the environment should be a top priority. The strategy should specifically address the collection of materials that are priorities for reuse or recycling. These materials should be segregated, collected, and managed under conditions that ensure they are preserved for future reuse or recycling. Remaining debris will likely be disposed. Ensuring that all debris is removed in a timely fashion, whether by designated debris haulers or through self-hauling by residents, is important to protecting the safety of the community and returning the community to its pre-disaster state.

Debris Segregation and Collection

To maximize reuse and recycling, reduce cross-contamination of materials, and avert future disposal problems, debris should be segregated into different material and waste streams as much as possible so that each debris stream may be properly managed. For example, C&D debris that cannot be reused, recycled, or combusted for energy can be managed in a C&D landfill. In many states, vegetative debris and building contents can also be disposed of in a C&D landfill. However, hazardous wastes



should be removed from commingled debris prior to disposal so that all the waste need not be managed as hazardous. Putrescible wastes should likewise be segregated and managed separately in accordance with all applicable regulations.

The collection strategy should specify, at a minimum, who would collect the debris, when specific debris streams would be collected, where debris would be hauled, and how the strategy would be communicated to the public. Planners should also consider how the location of the debris (i.e., whether the debris is on land, in waterways, or in sensitive habitats, such as shorelines, wetlands, and marshes, or other special areas) impacts its collection and removal. All collection strategies should seek to minimize the number of times debris is handled in order to reduce costs and increase efficiency. While debris can also be sorted at a temporary storage site or disposal site, segregating debris is most effectively performed at the original deposit point, such as through curbside or source separation. Thus, residents and businesses should be educated on segregating debris into specified piles, as determined by the community, allowing debris haulers to collect the different types of debris separately. Debris haulers can be residents, contractors, city, county, or tribal employees, volunteers, or a mixture of different groups. Figure 6 is an example of a curbside debris segregation diagram.

Figure 6. Example of Curbside Debris Removal Guidelines



Deconstruction techniques can be considered for standing buildings to help ensure that the materials will be segregated and in proper condition for reuse or recycling. More information about deconstruction can be found on BMRA’s website (<https://bmra.org/>) and the National Demolition Association’s website (<http://www.demolitionassociation.com>). Also, the C&D debris recycling industry has had several technological advances that make debris sorting and recycling more feasible. For example, portable hydraulic grinders are available that can handle wooden framing material and gypsum drywall at the job site. New screening systems have also been developed to facilitate and expedite sorting. Slow speed, high-torque shredders that reduce noise, dust, and vibration can shred mixed bulky materials. With prior planning and preparation, more efficient segregation of C&D debris is possible. More information about C&D debris recycling can be found on EPA’s website at <https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials>.

Some of the material and waste streams found in disaster debris have potential health or environmental implications. EPA advises that these types of debris should be segregated for special handling. A plan for controlling and diverting hazardous materials from the debris stream, including handling and collection procedures, can help avoid the release of hazardous constituents into the environment. For example, residents should be advised not to commingle HHW with other debris or dispose of HHW with their normal MSW. To prevent commingling, residents could be directed to bring HHW to a specified location or collection event. Alternatively, residents could be informed to set HHW at the curb for special collection. A sample flyer that was used to inform the public of HHW handling after Hurricane Katrina in Louisiana is included in Appendix C. Separating HHW and other hazardous waste from

nonhazardous and incompatible debris helps to limit the spread of contamination and prevent incompatible materials from reacting.

If a release of a hazardous substance should occur, contact the state environmental agency and the National Response Center (NRC) (<https://www.epa.gov/emergency-response/national-response-center>).



HHW Curbside Collection: Truck lined with bins to keep incompatible materials segregated.

Given the importance of segregating HHW and other harmful debris streams from commingled debris, monitoring incoming disaster debris can be important at debris management sites and disposal facilities. When a truck enters these areas, spotters should check the load for volume and debris streams not allowed at that site or facility. Spotters are also appropriate at the point where the truck tips its load at debris management sites or disposal facilities, as well as in the field where debris is being collected and sorted. Monitoring incoming debris helps prevent improper disposal of harmful debris streams, which minimizes the potential for current and future contamination.

Temporary Debris Management Sites

The amount of debris that one natural disaster generates may be greater than the amount of debris many communities handle in a year. For example, hurricanes can generate more vegetative debris than a municipality typically manages in a year, and blizzards may generate large amounts of animal carcasses that would need to be managed over and above what a community manages under normal conditions. Given the quantities of debris that may be generated, a community should not expect to be able to recycle, treat, dispose, or otherwise manage disaster debris immediately. Communities should also consider that local waste management facilities may be damaged or overwhelmed in the wake of a disaster. Therefore, one of the most common suggestions from communities that have experienced natural disasters is to pre-select multiple locations for temporary debris management sites that can be used to sort, store, and process debris during a disaster response. If specific sites cannot be identified prior to a disaster, communities should develop guidelines that can be used to designate sites during an incident.

Planning Ahead for Temporary Debris Management Sites

Pre-incident planning, including creating a debris management plan and stand-by contracts, can be key for community resilience. Without pre-planning, the state, county, and local governments may experience a much greater cost and a longer time frame to recover. Connecticut considers its pre-identification of temporary debris management sites to be the most valuable pre-disaster waste management-related activity. Using an inventory of state-owned lands (including state parks), Connecticut evaluated potential temporary debris management sites to serve as staging areas and vehicular and equipment sites for utilities and debris management contractors during natural disasters. Only sites that were consistent with FEMA's and EPA's planning guidance were selected. Upon activation of a temporary debris management site, the contractor or municipality notifies the Connecticut Department of Energy and Environmental Protection. At that time, the site selected for use by the state or municipality is logged into a database, and the requestor is issued an Emergency Authorization, which includes operating conditions and closure requirements. This information is made available to FEMA to help document costs incurred by the state and/or municipality. Many of these sites already have been used for multiple natural disasters, and the process to verify and secure authorization for a site is now well understood by most municipalities in Connecticut.

Temporary debris management sites also provide a community with time and space to further segregate and process debris. Processing of debris may be necessary to reduce its volume or toxicity prior to treatment or disposal. Volume reduction can be performed by grinding, shredding, or burning. Volume reduction not only lessens the burden on landfill capacity but also means that fewer trucks will be needed to transport debris,



reducing transportation costs and environmental impacts. These sites can also be used to manage debris streams that pose a potential threat to human health or the environment. For example, refrigerants in white goods like refrigerators, freezers, and window air conditioner units can be removed for proper handling.

To protect human health and the environment, sites should:

- Be of sufficient size with appropriate topography and soil type (planners can work with state or local environmental agencies to determine appropriate topography and soil type).
- Be located an appropriate distance from potable water wells and rivers, lakes, and streams (planners can work with state or local environmental agencies to determine appropriate setback distances).
- Not be located in a floodplain or wetland.
- Not cause harm to environmentally sensitive areas.
- Have controls in place to mitigate storm water runoff, erosion, fires, and dust.
- Be free from obstructions, such as power lines and pipelines.
- Be accessible to heavy equipment.
- Have limited access with only certain areas open to the public, such as debris drop-off areas, to ensure security. Additional storage controls and security measures may be necessary for some waste streams.
- Be located close to the impacted area but far enough away from residences, infrastructure, and businesses that could be affected by site operations. Sites can attract vectors, such as rodents and other pests, produce noise and odors at levels deemed unacceptable by residents, and put a large burden on normal traffic patterns.
- Be on public lands, which is preferred, because approval for this use is generally easier to obtain. However, private lands may be convenient and logistically necessary for temporary debris storage sites. Communities should consider potential agreements with private landowners to ensure the availability of these areas in advance.

In addition, temporary debris management sites should not be located where they can damage cultural resources and historic properties (e.g., by the trucking in and placement of large amounts of debris). The State Historic Preservation Officer or Tribal Historic Preservation Officer should be notified to ensure that these irreplaceable resources are not present or, if they are, remain protected from possible damage.

Consider additional safeguards for hazardous waste management sites:

- Cover area with two layers of plastic sheeting, tarps, or a concrete pad.
- Fence off area with T-posts and orange barricade fencing.
- Surround fenced-off area with absorbent booms to absorb potential leaks or sandbags to prevent spills from seeping into the ground.
- Use wooden pallets to raise collection bins off the ground to help identify potential leaks.
- Provide adequate space for walking and carrying items between pallets.

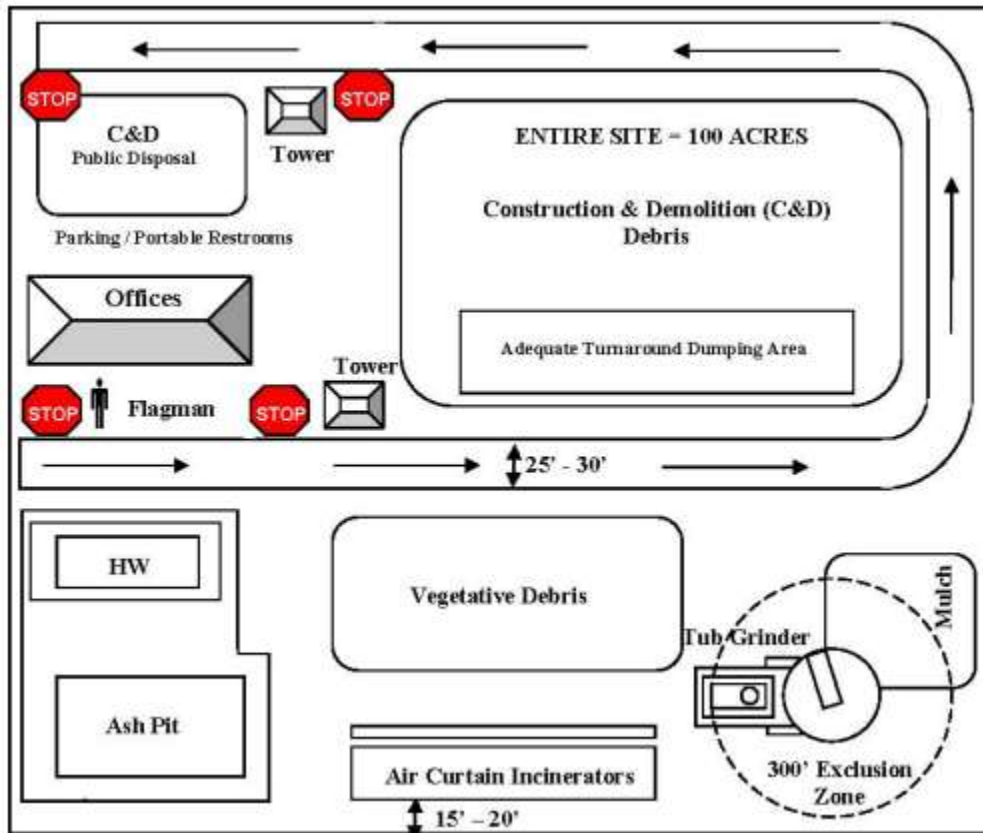
- Segregate containerized gases, liquids, or solids by material type (e.g., corrosive wastes, reactive wastes), place each material type in a separate bin or barrel, and label the bin or barrel appropriately.
- Cover collection bins or barrels with plastic liners or lids or cover the entire hazardous waste collection site with a tent to prevent water from entering the bins.
- Drums and other containers should be kept closed at all times except when waste is being added to the container.
- Place cylinders containing compressed gas upright and secure their caps. In addition, cylinders should be secured to some type of railing or post to prevent them from tipping over.
- Place sufficient fire extinguishers for the site in corners or in easily accessible locations in case of fire (four fire extinguishers per 10,000 square feet are recommended).

Information about a hazardous waste bulking site used in Louisiana after Hurricane Katrina can be found in Appendix C.

Identifying ample, suitable space to stage, store, and process debris can be a challenge. Sites selected in the past have included disposal facilities, transfer stations, parking lots, local parks, and closed industrial/military facilities. Conveniently located sites reduce travel time when transporting debris to management facilities and result in expedited debris cleanup.

Communities can also use these sites to distribute reusable or recycled products (such as free mulch or wood) to the public. According to FEMA, 100 acres of land are needed to process one million cubic yards of debris. Figure 7 depicts an example of a 100-acre debris management site that primarily manages nonhazardous debris. The site includes a location for hazardous waste (marked “HW”). Hazardous waste may be delivered to this location by mistake or be included with non-hazardous materials, if affected citizens are confused about how to categorize their waste or where they should take it.

Figure 7. Example of a Debris Management Site



Source: FEMA, 2007

The pre-existing condition of temporary debris management sites, such as the soil, groundwater, and/or surface water conditions, should be evaluated and documented prior to use. After these sites are no longer needed, communities should or may even be required to restore them to their original condition. Environmental monitoring and removing debris from the site in a timely manner to prevent odors, vectors, human health hazards, and environmental releases can help minimize damage to the site during operation. Guidelines should be established for the return of property to its owners.

If residents will be asked to bring debris to collection sites, a community should identify those locations in its pre-incident communication plan. This information should be immediately available to the public, especially since electrical outages may impede direct communication. A community should also plan for sufficient staffing for these sites and establish hours of operation that accommodate residents. Many communities have found that much residential debris cleanup takes place on weekends or after normal business hours.

Equipment and Staffing Needs

When drafting a debris management plan, planners should identify the types of equipment and supplies needed to implement the plan. A list of possible equipment needs is provided in Figure

8. A community should keep in mind that a natural disaster may impact the availability of its existing equipment and supplies. For example, in the event of flooding or a hurricane, mud or standing water may make it difficult for heavy equipment to reach the debris. Also, if a large number of vehicles and fuel-dependent equipment is needed, consider the possible implications of a fuel shortage due to the disaster. Potable water supplies should be well stocked for hurricane and flood seasons.

The health and safety of all response personnel, including contractors and volunteers, is very important. Personal protective equipment (PPE) and similar considerations should be addressed in the plan. The Occupational Safety and Health Administration (OSHA) produced a Hurricane eMatrix (<https://www.osha.gov/SLTC/etools/hurricane/index.html>) to provide recommendations on how to keep workers safe during the management of disaster debris. The eMatrix identifies types of necessary PPE and operational considerations. While the Hurricane eMatrix was designed for use after a hurricane, many of the recommendations can apply to other natural disasters.

In addition to equipment, communities may need more staff to carry out debris management-related activities. For instance, in the aftermath of a natural disaster, communities may need additional personnel to:

- Handle an increased number of telephone calls and requests concerning debris removal and management;
- Document the incident and waste management operations;
- Meet recordkeeping requirements for reimbursement of disaster debris management activities, such as FEMA's eligibility criteria for PA funding;
- Train and monitor debris management contractors;
- Oversee contracts;
- Haul debris out of neighborhoods;
- Troubleshoot problems;
- Monitor incoming debris at debris management sites;
- Staff multiple shifts; and
- Serve as backup to response personnel to help prevent them from becoming fatigued.

Communities could consider cross-training their existing staff to carry out several responsibilities related to disaster response and identify sources of temporary labor.

Additionally, in the aftermath of a widespread disaster, employees responsible for debris removal may be unable or have difficulty travelling to work sites. Roads may be blocked or otherwise impassable to drivers, and public transit services may be reduced or suspended. To help address this potential issue, a debris management plan should include coordination with local transportation entities.

Figure 8. Example Equipment Needs

Equipment needs can be separated into three priorities:

Primary – may be needed for initial response:

- Personal protective equipment (safety vests, work gloves, steel toe boots, hard hats, etc.)
- Safety items (first aid kits, water, sunscreen, shade canopies, etc.)
- Barrier tape or fencing
- Batteries
- Chainsaws
- Debris/earth moving equipment, such as skid-steer loaders, front loaders, and excavators
- Dump trucks and roll-off trucks
- Flares
- Flags, small and brightly colored
- Flashlights
- Fuel
- Generators
- Handheld Global Positioning System (GPS) units to record locations of debris
- Handheld radios, cell phones, satellite phones, and/or wireless handheld devices
- Notebooks and cameras
- Portable restrooms
- Road signs to direct debris hauler traffic
- Vehicle repair equipment

Secondary – may be needed to begin debris processing:

- Air, water, and soil monitoring equipment
- Cranes with cables and magnets
- Crushers (e.g., jaw, impact) and/or compactors
- Dumpsters and hoppers
- Forklifts
- Knuckle boom pickers (elevated work platforms)
- Jack hammers
- Pallets
- Plastic sheeting
- Sealable plastic drums
- Wood grinders

Tertiary – sometimes needed to process large volumes:

- Air curtain incinerators
- Conveyors
- Vibrating screen sorters

Pre-negotiated contracts or agreements may be put into place to acquire additional equipment and personnel from private companies in case the community does not have the capacity to provide for itself during a disaster response. Solicitations could include services for debris removal, sorting, storage, recycling, processing, marketing, and disposal. Pre-negotiated contracts may help get better prices than what might be offered once the natural disaster has occurred. They may also

Stand-by Contracts

The State of Connecticut executed two contracts in 2014 that provide the State with immediate assistance with debris management activities in the event that a disaster occurs. The contracts are for disaster debris response and management services and disaster debris monitoring services. These contracts are the result of a multi-agency effort, including Connecticut's Departments of Energy and Environmental Protection, Emergency Services and Public Protection, and Transportation. Copies of these contracts can be found on the State of Connecticut's Disaster Debris Management Preparedness website at http://www.ct.gov/deep/cwp/view.asp?a=2718&Q=410492&deepNav_GID=1646.

allow for any legal issues to be addressed in advance. Additionally, cleanup efforts can commence more quickly than if contract negotiations are necessary. Back-up copies of contract documentation should be kept in alternative locations in case one location is destroyed in the disaster.

If pre-negotiated contracts are not feasible, consider including in the debris management plan a list of pre-qualified contractors from whom to solicit proposals directly after the disaster. Entities excluded from receiving federal contracts can be searched on the U.S. government's System for Award Management (SAM) website (<https://sam.gov/portal>). Also, communities can use the SAM Disaster Response Registry to find contractors willing to provide debris removal and other disaster relief supplies and services during a natural disaster. To receive PA funding for contract costs for eligible work, applicants must comply with federal procurement and contracting requirements. For more information, see FEMA's PAPPG at <https://www.fema.gov/media-library/assets/documents/111781>. Also, FEMA established the Procurement Disaster Assistance Team to help PA applicants comply with federal procurement standards. Visit <https://www.fema.gov/procurement-disaster-assistance-team> for procurement-related resources, including required contract clauses, checklists, and key points regarding contracting practices.

Plans could also be made for the quick procurement of equipment and filling of staffing needs through mutual aid agreements with neighboring communities. Mutual aid agreements may allow the equipment, services, and expense burden to be shared. As other communities may have resources they are willing to share, planners should consider contacting nearby local governments in advance to set up mutual aid agreements and relevant state agencies to discuss their resources and available financial aid.

Community Communications/Outreach Plan

Community outreach and communication can be critical to the efficient and effective implementation of debris management activities. Therefore, a community communications/outreach plan is generally a key part of a debris management plan. During recovery, the community will likely have to communicate with the debris management team, other governmental agencies, local commercial and industrial enterprises, residential waste haulers, and the general public. EPA suggests that the communications plan contains contact information for key stakeholder groups, pre-scripted information, such as fact sheets, for debris management activities involving the public, and information for a response website. In addition, communities may want to include any special training, required PPE, and safety information for debris handlers and haulers, including volunteers and residents who are helping to clean up the debris.

Many communities that have experienced disasters commented that residents typically want debris to be removed as quickly as possible. Some residents may resort to illegal burning, dumping, and other improper management methods. Providing public education before and in the wake of the disaster can curb this response. Communities should inform the public when, where, and how debris collection will commence and when normal collection is likely to resume. They may also provide special instructions for handling and segregating disaster debris streams, such as HHW, ACM, and vegetative debris. To be as useful as possible, all communication should be timely, consistent, updated, and in language that is not overly technical. Also, information should be communicated in all of the languages that are represented in the community. Alternatively, the communications plan can address the need for interpreters/translators.

As part of their communications/outreach plans, some communities have prepared:

- Radio and television announcements;
- Flyers and door hangers;
- Telephone hotlines; and
- Response websites.

Planners should discuss the use of free public service advertising with local media companies to communicate instructions in the event of a natural disaster. Other forms of communication may include social media and public meetings. Depending on the type and severity of the natural disaster, however, a community might lose electricity, telephone service, radio broadcasting capability, or newspaper service. Communities, therefore, are encouraged to prepare more than one method of communication and begin public outreach before the disaster even hits. Examples of flyers used following Hurricane Katrina are presented in Appendix C.

Waste and Material Tracking and Reporting System

In order to inform federal, state, local, and tribal officials, as well as the public and media, that disaster debris is being managed appropriately, debris management activities should be made as

transparent as possible. The debris management plan should include a waste and material tracking and reporting system that can be implemented during a disaster response, such as the example in Figure 9. This system should be used to track debris from its original deposit point to its final destination. Communities should plan on making the data publicly available. Information on the origin, date of collection, characterization, and daily and cumulative quantities of the debris should be reported along with the debris management site, if applicable, and waste management facility where the debris was sent. The data should be organized and reported in a consistent manner.

Figure 9. Example of a Simple Waste and Material Tracking Template

Tracking waste from its point of generation to its final disposition can be done using a simple spreadsheet.

A	B	C	D	E	F	G	H	I
Point of Generation	Date	Waste Type	WM Staging Area	Amount Managed	Cumulative Amount Managed	Units	Waste Management Facility	Comments

Tracking information can also help determine the pay for debris haulers and the amount of used and available capacity at debris management sites and facilities. As contract debris haulers generally are paid on the basis of the volume of debris hauled, provisions in the debris management plan could be made for measuring truck carrying capacities and assigning each truck a number before the truck can collect debris. The assigned truck number allows for tracking debris amounts by each individual truck. Each truck would be monitored at the receiving facility for the volume of debris carried. The hauler would receive payment based on the sum of these volume amounts.

2.3 Keep the Debris Management Plan Updated

To maximize its usefulness in a disaster response, a pre-incident debris management plan should be a living document. A schedule for keeping the plan up-to-date should be established. For example, the planning team could review and exercise the plan once a year and revise it, as needed. Revisions may include:

- Updating capacity information for waste management facilities, including recycling facilities;
- Verifying the continued viability of pre-determined temporary debris management sites;
- Adding new reuse, recycling, and composting opportunities;
- Updating contact information for state, local, and tribal officials and waste management facilities;
- Incorporating new contracts or agreements;
- Documenting changes in available equipment and other resources;

- Incorporating new residential and commercial developments; and
- Changing debris types and quantities to correspond to changes in the community's character and building stock.

Planners should meet with stakeholders to review and update the plan regularly to ensure it reflects current practices and policies, including FEMA's PA requirements, changes in the community, lessons learned, and other information. To make sure the plan is current, accurate, thorough, and comprehensible, the whole community can participate in waste management-related exercises and similar trainings. The findings from the exercises should then be incorporated into the plan. Periodic exercises and trainings on the debris management plan are very important because they may reveal gaps or deficiencies, as well as familiarize stakeholders with the content. Therefore, the development of a training plan to address training needs for staff and equipment operation should be part of plan maintenance.

Communities should make sure that any updates to the plan are communicated to state officials, health officials, neighboring communities, police and other emergency responders, and other stakeholders, as necessary. Sharing the plan with stakeholders will help to ensure that the plan is readily accessible post-disaster so that debris management activities can begin immediately in a manner protective of human health and the environment.

2.4 Implement the Debris Management Plan During a Natural Disaster

After a natural disaster occurs, debris management will be necessary. Although each disaster response is different, many debris management-related issues and decisions are similar across disasters. Pre-incident debris management planning can help facilitate the decision-making process during and after a disaster by providing preliminary information on how debris generated by the disaster may be managed. For example, pre-identified waste management facilities should be notified of anticipated needs, and pre-negotiated contract support should be exercised where necessary. In other words, the general information in the pre-incident plan should form the basis of the disaster-specific debris management plan. The disaster-specific plan should then be updated with disaster-specific information, including estimated debris quantities, debris locations, and locations of operational debris management sites and facilities.

3 Lessons Learned from Past Disasters

3.1 Best Management Practices

The best management practices included here are drawn from the experiences of communities in responding to natural disasters. Pre-incident planning, using existing resources, debris segregation, and clear and consistent communication have all proven to be essential practices in making debris management as efficient as possible during a response.

PRE-INCIDENT PLANNING

Having a plan for dealing with disaster debris was consistently identified as one of the most significant steps a community could take to facilitate disaster response. The following planning activities have proven particularly useful in past disasters:

- Forecasting debris types and volumes: Forecasting the amount of each possible debris stream that may be generated helps communities determine their debris management needs. Some areas may be more impacted than others (e.g., flood zones), becoming major sources of debris.
- Pre-identifying debris management sites and facilities: Pre-identified debris management sites (e.g., staging sites) and facilities (e.g., landfills) can aid response efforts. In addition to determining potential locations, planners should determine the types and amount of debris the sites and facilities can handle. For example, consider the processing capacity of nearby recycling plants or available capacity of nearby landfills.
- Pre-negotiating contracts: Planning for debris management should include identifying equipment, staffing, and other debris management needs and pre-negotiating contracts for obtaining those needs in the event of a disaster. Identifying pre-qualified contractors and contracting needs in advance can save time and money during disaster response efforts. Also, after a major disaster, other communities may be competing for the same resources, which may be limited. Having contracts in place before a disaster occurs may safeguard those resources for the specific community.

USING EXISTING RESOURCES

One of the best strategies for saving time and money during a response is to take advantage of existing resources within and outside the community, including federal, regional, state, and private resources. Utilizing available resources like supplies, equipment, existing infrastructure (e.g., recycling programs, waste management facilities), experienced debris management teams, and funding programs can facilitate the speed and ease of debris management efforts.

Communities should determine what resources are available to them before a natural disaster occurs. A community's pre-incident planning should include familiarizing itself with federal, regional, state, and private programs and plans that may be relevant to response efforts.

DEBRIS SEGREGATION

Communities have identified debris segregation and site monitoring as important debris management activities during a response. Debris segregation ideally should take place at the original deposit point (e.g., through curbside or source separation). Past debris management efforts have demonstrated that debris becomes increasingly difficult to segregate after collection. As debris becomes more commingled, segregating the debris becomes less cost-effective and more resource-intensive, making it less likely that debris will be segregated. However, planning and organization can facilitate debris segregation at debris management sites and facilities as necessary. Incoming debris at debris management sites and facilities should be monitored to ensure proper segregation, even when debris is segregated at the source. Debris segregation protocols for responders and contractors should be created to promote reuse, recycling, and proper disposal of debris.

CLEAR AND CONSISTENT COMMUNICATION

Communication with the public and between different groups of responders is a key part to the successful management of disaster debris. Communicating with the public before the disaster occurs can be highly beneficial. Easily accessible information provided through websites and local media can help increase resident participation and cooperation in response efforts. Outreach should be coordinated between federal, state, and local officials to provide consistent information to the public. Interagency communication also ensures consistency, improving the efficiency of response efforts. A community's communications strategy should seek to improve information sharing by establishing a main point of contact, a specific date and time for calls and meetings, or alternative methods to ensure effective communication within the community on debris management issues.

3.2 Case Studies

The following case studies were provided by various federal, state, and local sources. Figure 10 provides a quick summary that highlights whether pre-incident planning, working with community stakeholders (e.g., businesses, residents), effective communication, debris recycling, source-separation of debris, and the issue of insufficient landfill space are illustrated in each case study. Although pre-incident planning did not play a role in all of these case studies, these case studies nevertheless demonstrate the benefits of disaster debris planning and express some of the challenges that communities have faced when managing disaster debris. Communities should use these real-life experiences to reevaluate and revise their own disaster debris management policies and debris management plans.

EPA acknowledges that case studies for the 2017 natural disasters, such as the northern California firestorm, Hurricane Harvey, Hurricane Irma, and Hurricane Maria, would be helpful in informing further content for this guidance. However, recovery from these disasters is still ongoing as of development of this guidance, and lessons learned are not yet available at this time. For example, debris generated by Hurricane Harvey, which made landfall in Texas in August 2017, is still being collected. Preliminary totals from FEMA, as of February 2018,

estimate over 11.9 million cubic yards of debris collected, which is about 75 percent of the anticipated total. (See Commission To Rebuild Texas After Hurricane Harvey Update: Issue 17 at <https://gov.texas.gov/news/post/commission-to-rebuild-texas-after-hurricane-harvey-update-issue-17>). Subsequent versions of this guidance will incorporate lessons learned from these disasters.

Case studies are included for the following disasters:

- Los Angeles, CA: The Northridge Earthquake 1994
- San Diego County, CA: Cedar and Pines Fires 2003
- Florida: Hurricanes 2004
- Louisiana: Hurricanes Katrina and Rita 2005
- Mississippi: Hurricane Katrina 2005
- Alstead, NH: Flooding 2005
- Joplin, MO: Tornado 2011
- New York City, NY: Hurricane Sandy 2012
- St. Louis Metro Area, MO: Floods 2015

Figure 10. Case Studies Summary

	Pre-incident planning	Worked with Community Stakeholders	Effective communication	Debris Recycling	Source-separation of debris	Insufficient landfill space
<i>Los Angeles, CA: The Northridge Earthquake 1994</i>	✓		✓	✓		
<i>San Diego County, CA: Cedar and Pines Fires 2003</i>	✓	✓	✓	✓		✓
<i>Florida: Hurricanes 2004</i>	✓		✓	✓		
<i>Louisiana: Hurricanes Katrina and Rita 2005</i>	✓		✓	✓		
<i>Mississippi: Hurricane Katrina 2005</i>	✓		✓			✓
<i>Alstead, NH: Flooding 2005</i>	✓					
<i>Joplin, MO: Tornado 2011</i>	✓	✓	✓	✓		
<i>New York City, NY: Hurricane Sandy 2012</i>			✓	✓		
<i>St. Louis Metro Area, MO: Floods 2015</i>	✓	✓	✓			

More recommendations can be found in the Solid Waste Association of North America’s (SWANA’s) document on “Hurricane Katrina Disaster Debris Management: Lessons Learned from State and Local Governments” (2005) (<http://swana.org/Portals/0/News/2005/HurricaneKatrinaDisasterDebrisManagementReport-12-22-05.pdf>). This document discusses advice given to Louisiana and Mississippi from SWANA members that have experienced many different types of disasters. SWANA represents thousands of solid waste professionals (<http://www.swana.org>).

Los Angeles, CA: The Northridge Earthquake 1994

The Northridge Earthquake struck the City of Los Angeles at 4:30 am on January 17, 1994. It had a magnitude of 6.8 and aftershocks with a magnitude of 5.9. In approximately one minute, the Northridge Earthquake spread over approximately 2,100 square miles, damaged 114,000 structures, and caused 72 deaths. The earthquake also caused 50 structural fires, ruptured gas and water mains, caused power outages, and extensively damaged highway networks, costing the city \$300 million. The City of Los Angeles did not have a debris management plan prior to the earthquake, and the city had to develop debris management procedures after it occurred.

The city relied heavily on recycling to manage the debris. The day after the earthquake struck, Los Angeles instituted a curbside debris collection program. The city negotiated with FEMA to designate recycling as the preferred method of debris management and developed contracts with existing businesses to recycle clean, source-separated materials. Los Angeles worked with more than nine businesses to develop processing capacity for commingled debris. By midsummer, about six months later, the city was able to recycle approximately 56% of the earthquake debris collected, totaling over 1.5 million tons.

After two months of negotiation, FEMA allowed the city to include recycling as a debris management method. This decision was based primarily on the city's local policy supporting recycling and a pilot program demonstrating a potential 82% recycling rate. FEMA funded the debris recycling program, including paying recycling facility tipping fees and the costs associated with hiring data entry staff and contracting with a consultant to manage recycling efforts. Recycling also saved the city transportation costs because recycling facilities were closer to the devastated areas than disposal sites. California's Integrated Waste Management Board helped Los Angeles obtain this funding by writing a letter to FEMA stating that recycling was state policy. Los Angeles, like every community in California, submitted a plan for source reduction, recycling, and composting under the state's Integrated Waste Management and Litter Reduction Act. Because Los Angeles had a recycling policy prior to the earthquake, FEMA determined that the city did not need to demonstrate that recycling would save money in order to obtain FEMA funding.

Communication

Soon after the earthquake, officials announced curbside collection instructions through various media outlets. Initial instructions allowed residents to leave commingled debris at the curb in large piles. As the response progressed, however, officials requested that residents segregate concrete and asphalt, soil, red clay brick, wood, and other materials. Because residents had become accustomed to commingling their debris for pickup, City officials worked to convince residents to follow these more stringent guidelines. The city attempted to communicate the new requirements through door hangers that were distributed to residents. However, this strategy failed to yield changes in residents' behaviors. Consequently, the city employed work crews to separate the debris on the residents' behalf before the debris was hauled away. When residents placed yard trimmings or other non-earthquake-related debris on the curb, workers

left door hangers explaining why these materials were not picked up and provided directions on how to reuse, recycle, and dispose of them.

Los Angeles relied on both residents and City staff to determine which locations needed debris removal. A telephone hotline staffed by multilingual operators accepted residents' requests for debris removal. The staff maintained a GIS database and regularly produced maps marking pickup locations based on callers' addresses. At the same time, City inspectors supervising debris management activities reported streets that were ready for debris pickup.

Collection and Segregation

Prior to the earthquake, C&D debris composed approximately 10-15% of Los Angeles' debris stream. After the earthquake, the amount of C&D debris increased from 150 tons per day to 10,000 tons per day. City officials updated an existing list of licensed, insured debris removal contractors. They held an orientation meeting and signed contracts for debris removal. Initial contracts for debris removal were only two pages long and expired after one week of work. These early contracts allowed Los Angeles to begin removing debris quickly but did not include recycling, subcontracting parameters, or other requirements. Contracts eventually grew to 22 pages in length. The city assigned each contractor a grid of streets to clear. City inspectors monitored contractors and tracked debris collection. When contracts expired, Los Angeles placed them at the end of the approved contractors list and called them again when their turns came.

Contractors separated wood, metal, soil, concrete and asphalt, and red clay brick. Most of the debris collected was recyclable. Recyclers crushed concrete and asphalt (mixed with up to 15% soil) and sold it for use as sub-base in roads. They reused soil as landfill cover and soil amendment. They ground and screened wood, selling fine pieces by the cubic yard for landscaping and coarse pieces for compost or biomass fuel. Recycling facilities either ground up brick for use on baseball infields or chipped it for use in landscaping. Scrap metal dealers recycled metal waste.

Los Angeles required its contractors to send commingled debris to four facilities for recycling. Two of these facilities used an automated process that screened out fine debris and sent the remainder along a conveyor belt where workers removed and separated wood, brick, metal, and trash by hand. A vibrating screen removed any soil left in the remaining stream. At the end of the process, only concrete and asphalt aggregate was left. These facilities were able to recycle approximately 80% of the commingled debris.

Los Angeles also worked to promote recycling by providing incentives to haulers. City officials required haulers to develop a recycling plan that included scouting for recyclables and dedicating trucks to a specific type of debris so that debris separated at the curb was not commingled in the truck. Los Angeles also created contract incentives that prioritized source-separated recycling over commingled recycling. These efforts allowed the city to expand its C&D recycling capacity by approximately 10,000 tons per day.

The California Office of Emergency Services issued emergency regulations expanding permit hours for solid waste facilities. All debris was initially disposed of in three landfills. In about a year, the city added one more landfill and 18 recycling facilities. This expansion also helped meet the city's long-term goal to increase the recycling of C&D debris in non-emergency situations.

More information about recycling in California can be found on California's Department of Resources Recycling and Recovery (CalRecycle) website at <http://www.calrecycle.ca.gov/default.asp>.

San Diego County, CA: Cedar and Pines Fires 2003

In October 2003, two wildfires burned more than 400,000 acres of land and destroyed nearly 6,000 structures and 4,000 vehicles throughout San Diego County. The fire lasted for 14 days and, at its height, advanced at a rate of two acres per second. The San Diego County Office of Public Works responded immediately, focusing all available resources on the recovery effort. A plan was in place within a week, and the debris removal effort commenced approximately six weeks after the fires began. Overall, more than 128,000 tons of debris were collected in the wake of the fires.

Approximately 74,000 tons of concrete, metal, and vegetative debris were recycled, resulting in a recycling rate of nearly 60% and preserving more than 185,000 cubic yards of landfill space. The county had two incentives to recycle disaster debris. At the time of the fires, California state law required a 50% diversion rate for waste. The county could deduct the wildfire debris tonnages from the annual disposal tonnages after demonstrating that a majority of the recyclables were diverted. Also, the county projected that their existing landfill had only four more years left before reaching capacity and wanted to conserve landfill space.

While San Diego County had an emergency response plan in place before the fires, this plan did not address debris management. During the first few weeks after the fires, county officials focused on securing contractors to collect, transport, manage, and monitor debris through a competitive bid process and established a fire debris assistance hotline. Subsequently, the county identified their lack of debris planning as a major challenge. The county believed that having a debris management plan in place would have saved time and eased the FEMA reimbursement process.

Communication

County officials quickly established a fully staffed, eight-hour-a-day, fire debris hotline that provided the public with information detailing all aspects of the county's fire debris removal efforts. The hotline served as a starting point for cleanup efforts and also gave residents information on erosion control and volunteer coordination. Hotline activity dramatically increased after the county announced its free debris removal services; more than 2,500 calls were received related to its bin program. Additional public assistance was offered through the

county's website. A dedicated webpage included an ash and debris cleanup guidance document that was developed in collaboration with the Regional Water Quality Control Board.

Collection and Segregation

San Diego County provided empty roll-off bins (typically 30 or 40 cubic yards each) to be used by citizens to remove debris from their property. This service was provided at no cost to the fire victims. The bins were requested by both individual property owners and by communities cleaning multiple properties. These bins were intended for use by the surrounding community; owners of the properties on which the bins were placed were required to sign right-to-enter forms. Thus, anyone in the surrounding areas could use the bins, not just the property owners who requested them.

Residents were given written instructions to separate metals and wood into the provided recycling bins. Another bin was then delivered for all remaining commingled debris materials. More than 1,500 bins provided the infrastructure necessary for the management of over 10,000 tons of debris. County officials concluded that the bin program was very successful in assisting in the timely cleanup of fire debris from structures.

Most HHW had been consumed in the fires due to the intensity of the heat. Remaining HHW was collected to ensure the health of volunteers, workers, and the general public. San Diego County held three HHW collection events following the wildfires. The county collected more than 82,000 pounds of material at the events, 13,000 pounds of which came from fire victims. The county also established a burned vehicle program that collected and recycled more than 4,000 vehicles.

San Diego County's Department of Public Works can be found at <http://www.sandiegocounty.gov/dpw/>. The "County of San Diego Debris Removal and Recycling Programs for the 2003 Cedar & Paradise Fires Final Report" is located at <http://www.calrecycle.ca.gov/Disaster/Fires2003/SDiegoRpt.pdf>.

Florida: Hurricanes 2004

During the 2004 hurricane season, Florida was hit by four hurricanes in rapid succession – Hurricanes Charley, Frances, Ivan, and Jeanne. Many of the counties in Florida were impacted by at least two of these hurricanes. In total, the four hurricanes caused 47 deaths, displaced approximately 1.7 million people, and resulted in over \$45 billion in damages. The case studies below describe Palm Beach County's response to Hurricanes Frances and Jeanne and Escambia County's response to Hurricane Ivan.

PALM BEACH COUNTY: HURRICANES FRANCES AND JEANNE

On September 3, 2004, Palm Beach County, Florida was hit by Hurricane Frances. The county's Solid Waste Authority (SWA) immediately established nine temporary debris management sites throughout the county. Three weeks later, the county was hit by Hurricane Jeanne. With winds exceeding 115 miles per hour, these two powerful storms caused a large amount of damage to

the county. Palm Beach County had created a debris management plan after Hurricane Irene in 1999. The disaster plan included information on restoring public infrastructure, locating and securing temporary debris storage sites, clearing roads for emergency personnel, and facilitating federal reimbursement. The plan also contained pre-existing contracts with trained and qualified debris management contractors who could provide services in the event of a disaster. FEMA-approved contractors, subcontractors, and vendors were employed in debris collection and management processes.

Communication

SWA conducted a public information campaign before hurricane season to educate the public about curbside collection and segregation of vegetative from commingled debris. The campaign proved to be very effective in shaping the public response during recovery efforts. In the hours before Hurricane Frances made landfall, SWA began communicating with the public through the Palm Beach County Emergency Operations Center. The initial message declared that the county would resume normal perishable garbage collection as quickly as possible and instructed residents to keep garbage separated from storm debris. SWA also opened its information hotline within hours immediately following the storm to answer resident questions. The customer service information staff received and processed more than 100,000 phone calls between the day that Hurricane Frances hit and the beginning of November 2004, a period of two months.

Collection and Segregation

SWA coordinated with local contractors and haulers to clear more than two million cubic yards of debris from roadways and neighborhoods. Temporary debris collection sites were established at nine locations two days after Hurricane Frances passed. Approximately four million cubic yards of debris were collected and processed at these sites over three months.

The majority of the debris that Palm Beach County managed was vegetative debris. Approximately 80% of the debris generated was vegetative debris and 20% was commingled debris. In order to conserve landfill space, more than three million cubic yards of vegetative debris were ground up and consolidated into chipped mulch. SWA used about 872,000 cubic yards of mulch for land application on agricultural land in western Palm Beach County. Overall, the county was able to conserve more than 25 acres of landfill space.

Palm Beach County's current Debris Management Plan can be found at <http://www.swa.org/152/Plans-Documents>.

ESCAMBIA COUNTY: HURRICANE IVAN

Hurricane Ivan made landfall on the coast of Florida on September 15, 2004 with winds exceeding 130 mph. Escambia County, including the Pensacola metropolitan area, was impacted by the storm's eastern eyewall, which produced the strongest wind gusts and heaviest rain bands. The storm generated more than 10 million cubic yards of debris in a 12-hour period.

Communication

As soon as the area was placed under a hurricane warning, Escambia County officials began issuing public service announcements over radio and TV networks. Residents were urged to segregate debris generated by the hurricane from other household or municipal solid wastes. These messages continued throughout the event and were the primary means of communication with the public until newspapers resumed operations. A debris hotline was established after Hurricane Ivan that remained in operation through 2005, contributing to cleanup efforts for Hurricanes Dennis and Katrina. Escambia County officials learned that communication with the public should be ongoing through a public awareness campaign. Making the public aware of the county's debris management procedures and policies would help the public plan and react in a more efficient way.

Collection and Segregation

Escambia County Solid Waste Management Department officials had a hurricane debris management plan in place prior to Hurricane Ivan. After the hurricane, Escambia County personnel and Florida Department of Transportation road crews worked to clear debris from major roadways as soon as it was safe. Clearing the roadways by cutting and staging downed trees was the county's first priority and provided time for County officials to secure contractors. During the development of the plan, private contractors submitted information to be placed on a list of potential debris management service providers. These contractors were not pre-qualified, which slowed the county's initial evaluation process after the storm hit. It took 12 days to select three contractors and finalize rates and contracts. The county's current debris management plan contains pre-qualified debris contractors, enabling the county to mobilize and engage them prior to the arrival of another hurricane or disaster.

Once contracts were in place, the contractors identified the means of debris management. Vegetative debris held value and was marketable so it was ground into mulch and then managed through incineration, land application, and as raw material in paper mills. Of the more than 6.5 million cubic yards of vegetative debris managed by the county, 60% was exported to Italy as biomass for energy generation, 15% sold to paper mills, 15% used as landfill cover, and 10% incinerated with on-site air curtain incinerators. The county's debris management plan identified potential temporary debris storage and processing sites, including many county-owned parks that could easily be converted back to recreational facilities after debris was removed. However, the county would have experienced a major shortage in storage capacity had it also not added new sites. For example, the Blue Angel Recreation Area (formerly the Bronson Field Naval Air Station) was a large debris site used to process vegetative debris into mulch that was not included in the original plan. Approximately two million cubic yards of debris were processed at the Navy-owned recreation area and exported to Italy after the contractors brokered a deal for its use as biomass fuel in power plants.

Another major debris stream from Hurricane Ivan was the sand displaced throughout the barrier islands of Escambia County. The storm eroded beaches and dune systems and deposited the sand onto roadways, beachfront properties, and in Escambia Bay. More than 1.35 million

cubic yards of sand were displaced. After being filtered through a screen in order to remove contaminants and comply with beach sand composition restrictions, approximately 95% of the displaced sand was recovered and reused to establish a five-year protective berm.

In total, the county successfully diverted more than half of the debris from disposal in landfills. Information on emergency management in Escambia County can be found at <https://myescambia.com/our-services/public-safety/beready>.

Louisiana: Hurricanes Katrina and Rita 2005

On August 29, 2005, Hurricane Katrina struck southeastern Louisiana, causing widespread damage along the coastline and in New Orleans. Hurricane Katrina resulted in more than 1,600 fatalities and destroyed over a million homes. Hurricane Katrina overwhelmed the New Orleans levee system, breaching it and flooding approximately 80% of the city. The worst-off areas in the city were under nearly 20 feet of water. Some areas remained underwater for weeks. Katrina created 2.5 million power outages and displaced more than 770,000 people from their homes. The storm surge and flooding from Katrina also resulted in approximately 7.4 million gallons of spilled oil and the contamination of nearly 500 facilities with high quantities of hazardous chemicals, including 31 hazardous waste sites, 16 Superfund sites, and 170 drinking facilities. On September 24, 2005, Hurricane Rita made landfall near the Louisiana/Texas border, impacting several parishes in southwestern Louisiana and counties in Texas.

The Louisiana Department of Environmental Quality (LDEQ) issued its first emergency declaration on August 30, 2005. This declaration addressed some debris management issues. Thereafter, LDEQ developed a debris management plan.

The hurricanes resulted in 64.3 million cubic yards of debris in Louisiana. Overall, Louisiana received \$19.61 billion from FEMA for recovery, rebuilding, and mitigation of future damages.

Communication

LDEQ, together with EPA and the USCG, formed a unified command, which facilitated debris management and recycling discussions between LDEQ and EPA. Daily communication was established with USACE and FEMA. Outreach to citizens was facilitated through flyers, websites, TV and radio announcements, and news releases.

Although Louisiana had an Emergency Alert System, Louisiana did not utilize it before Hurricane Katrina. Before landfall, NOAA's National Weather Service issued warnings using NOAA Weather Radio All-Hazards (NWR) and the internet. After landfall, the National Weather Service issued live updates on hazards through both NWR and the Emergency Alert System and sent reports to local media outlets and emergency responders.

Many cell towers and phone switchboard centers were disrupted. Fifty percent of radio stations and forty-four percent of television stations, in addition to 38,911 response centers, went out of commission because of the hurricane and resulting flooding. Additionally, many fire department facilities had to be closed due to the flooding, and the New Orleans Mayor's Office,

which was forced to relocate to a nearby hotel, was unreachable for two days. Because of damage to telephone and power lines, cell towers, and other important components of communication infrastructure, responders had difficulty coordinating emergency efforts.

Collection and Segregation

Louisiana's emergency order lessened disposal restrictions on C&D debris in order to more quickly remove and dispose of massive quantities of debris. Debris, such as HHW, treated wood, carpeting, and ACM, were allowed to be disposed of at C&D landfills. However, several health and environmental concerns resulted from the lack of impermeable liners at many of these C&D landfills. Drywall dumped at these C&D landfills produced H₂S gas. Arsenic from treated wood and HHW resulted in harmful leachates into the surface and groundwater. Determining acceptable disposal sites in advance and considering disposal capabilities, permitting, and the importance of liners and monitoring systems for specific debris streams can help reduce later health and environmental problems.

Generally, vegetative debris was chipped or ground. Though responders recognized that vegetative debris could be used for energy recovery, an infestation of Formosan termites in southern parishes resulted in transportation restrictions. Consequently, twelve parishes quarantined vegetative debris and much of it was used as cover at landfills.

Since the State of Louisiana had identified recycling as a priority, both state and federal partners made efforts to recycle. EPA led curbside collection of HHW in most parishes. EPA developed a plan for the collection and recycling of HHW and coordinated daily with USACE to ensure that these materials were properly segregated. USACE added incentives to contracts, ensuring that their contractors conducted curbside debris segregation. Additionally, the importance of curbside segregation and details about debris collection were communicated to the public through fliers (see Appendix C for an example). As many as fifteen HHW collection centers were operating at one time. As a result of these combined efforts, over twenty-four million pounds of HHW were collected. Much of this waste was recycled, including batteries, propane cylinders, gasoline, and oil.

Over 500,000 damaged homes were identified after the flooding subsided. Many of these homes were estimated to have at least two televisions and one personal computer. In addition, numerous electronic items, such as game consoles, musical equipment, and stereo equipment, were discarded after the hurricane. EPA and USACE worked to collect and recycle damaged electronic equipment in New Orleans and surrounding areas. EPA established seven e-waste staging sites in and around New Orleans where trucks would wait for USACE and EPA personnel to sort the electronics into different electronic debris areas. Over 602,711 units of discarded e-waste were collected and properly recycled. The federal partners were able to ensure that the electronics were being properly recycled in a cost-effective manner through the use of EPA's Recycling Electronics and Asset Disposition (READ) Services. Private partners, including Dell Computer and Best Buy, expressed interest in helping with the Katrina electronics recycling effort. Both companies sponsored electronics collection events in the New Orleans area.

LDEQ specified in its Emergency Declaration that all white goods must be recycled. EPA, USACE, and local contractors worked together to collect, stage, clean, and recycle nearly 900,000 units of white goods. Refrigerant was extracted and largely recycled; steel from the units was reclaimed.

Louisiana's Governor's Office requested that LDEQ collect damaged vehicles and vessels. As of July 2007, approximately 12,000 vehicles and vessels had been collected from the public right-of-ways and private property. The vessels ranged in size from small fishing boats and wave runners to 100-foot steel-hulled shrimp boats and barges. At the individual pickup/collection points on the highways, the contracts called for site remediation of leaking fuels and similar measures. After proper notifications to the registered owners, all lead batteries, mercury switches, freon, antifreeze, fuels, and oil reservoirs were drained. Contractors were also required to inspect for and remove any stoves, refrigerators, ammunition, or other explosives that were found. All collected materials were inventoried and sent for recycling. The remaining metals, such as aluminum masts and lead keels from sailboats, copper wiring, and steel from vehicles, were separated, crushed, and recycled.

Guidance given by EPA regarding disaster debris management following Hurricane Katrina can be found at <https://archive.epa.gov/katrina/web/html/>.

Mississippi: Hurricane Katrina 2005

Hurricane Katrina made landfall in Mississippi on August 29, 2005 and moved up the eastern side of Mississippi. The slow speed of the hurricane and the shallow waters off Mississippi's Gulf Coast created an abnormally large storm surge that reached up to 30 feet. In addition to damage from the storm surge, Mississippi experienced extensive damage from the winds. Hurricane Katrina resulted in about 46 million cubic yards of debris and over 230 deaths in Mississippi. Over 24 million cubic yards of debris were generated in the three Gulf Coast counties of Hancock, Harrison, and Jackson. Approximately 70% (or over 17 million cubic yards) of the debris in these three coastal counties consisted of C&D debris, and the remaining 30% (or just over seven million cubic yards) of the debris produced consisted of vegetative debris. Mississippi received \$3.2 billion in funding from FEMA for debris removal, emergency response, and infrastructure repair.

Communication

To respond to debris management issues, the Mississippi Department of Environmental Quality (MDEQ) stationed a team of engineers, scientists, and emergency responders on the coast to assist local governments, industries, businesses, and other organizations with monitoring and decision-making related to debris management issues. The team was from MDEQ's headquarters in Jackson because the South Regional Office, which is located in Biloxi, was not able to provide support after the storm. The regional office was significantly damaged, and several of the employees lost their homes and suffered other personal damage. MDEQ

conducted daily conference calls between headquarters and the response team to address various debris management-related issues.

MDEQ also established a debris response station and call center at its headquarters. MDEQ engineers, scientists, data management specialists, and other personnel helped with the planning and decision-making for the response and the handling of public complaints and inquiries, as well as worked with other state and federal agencies to assist citizens with debris management issues and other environmental and public health problems. For example, MDEQ participated in a Joint Debris Task Force with federal and state agencies. The Debris Task Force, led by FEMA, included representatives from MDEQ, the State Forestry Commission, the State Department of Agriculture and Commerce, the State Department of Archives and History, EPA, USACE, USCG, and various other agencies. The Task Force met weekly, discussed debris management problems, and worked together on a joint resolution of those problems. In addition, MDEQ worked with local emergency management personnel, local solid waste management personnel, volunteer groups, the State Department of Health, local landfills, and disposal contractors to address debris management issues. MDEQ maintained a system to track the resolution of calls.

Collection and Segregation

MDEQ had to address the large amount of debris from homes, commercial buildings, and other structures. Immediately after the storm, MDEQ conducted an evaluation of the recycling capabilities and existing landfill capacity on the Gulf Coast. This evaluation indicated that large-scale recycling of the disaster debris would be difficult because the materials were mixed together, contaminated, or damaged beyond recovery. The evaluation also revealed that many counties suffered a significant shortfall in landfill capacity. MDEQ, working with local governments, had to consider new emergency landfill sites for the debris, as well as other debris management options. The emergency landfill sites, upon approval, operated temporarily until debris cleanup was completed. MDEQ determined that some landfill capacity should be preserved for the future needs of the counties given that large volumes of wastes would also be generated during reconstruction efforts. MDEQ worked with local governments in the three coastal counties to approve thirteen temporary emergency landfill sites in addition to the six pre-existing permitted landfills. These thirteen temporary emergency landfill sites and six permitted landfills received the bulk of the 17 million cubic yards of C&D debris.

Overall, some 340 temporary sites were approved for managing the debris generated by Hurricane Katrina. Of the 340 sites, more than 250 were chip or burn sites for vegetative debris. Approximately 30 new staging and 80 new burial sites were approved. The disposal sites were used primarily for the disposal of non-recyclable vegetative debris. In addition to the considerations in approving and operating emergency sites, MDEQ worked with FEMA to ensure proper closure of disposal, mulch, burn, and staging sites. As of August 31, 2007, most of the 340 emergency debris management sites had been closed.

MDEQ prioritized the protection of groundwater and surface water resources in developing the temporary emergency landfill sites. Existing landfills had already gone through an extensive environmental review during the permitting process to ensure that their locations were

geologically suitable to protect groundwater resources. MDEQ evaluated each of the thirteen temporary emergency landfill sites to determine if the underlying geology and groundwater conditions at the sites were suitable for debris disposal. Sites that did not have suitable underlying clay soils or where groundwater was unacceptably close to the surface were not approved for disposal of the hurricane debris. With FEMA's assistance, MDEQ installed groundwater monitoring systems at each of the thirteen emergency landfill sites and the six permitted existing landfills that took the Katrina debris. MDEQ also evaluated these sites for other concerns, including the protection of nearby wetlands and surface waters (such as rivers, streams, or bayous), proximity to residences and other types of structures, and proximity to the debris to attempt to minimize the distances that wastes would need to be transported. MDEQ maintained a daily presence at these emergency landfill sites during the response to ensure that the sites were being operated in a manner that was protective of the state's natural resources.

At staging and temporary storage sites established by MDEQ in coordination with local governments and USACE, vegetative debris, white goods, electronics, hazardous materials, and other materials were segregated for proper management. Over the course of the response, sites were also established for staging damaged boats and automobiles, crushing concrete, staging debris removed from state waters, and other activities. MDEQ required that the sites be operated in a manner that was protective of the environment and that prevented public nuisances and other problems.

Vegetative debris was mulched or burned to reduce volume. Conditions were developed for locating burn sites that included various set back distances and location stipulations to avoid problems and nuisances for local citizens. MDEQ developed an ash-use policy that would allow burn sites to propose beneficial use of the debris ash as a soil conditioner upon appropriate sampling. In addition, MDEQ worked with USACE to promote use of the millions of cubic yards of mulch created as boiler fuel, soil treatments for agriculture, and landscaping around municipal and county properties, golf courses, schools, and other sites. Mulch was also used in the live oak recovery efforts along the Gulf Coast, helping the trees recover from the surge and wind damage of Hurricane Katrina. Despite finding these varied uses for the mulch, the volume was so great that MDEQ had to create additional management sites in some communities strictly for mulch for which no market or end use could be found. This problem became more urgent when several large mulch piles in the southern part of the state began to spontaneously combust. MDEQ worked with USACE at that time to evaluate and approve emergency disposal sites for mulch.

Perhaps the greatest recycling success was with white goods and similar metals. In the three coastal counties, more than 24,000 tons of metal were collected, baled, and recycled. An estimated 450,000 refrigerators, freezers, washers, dryers, and hot water heater units were recycled. Approximately 1,500 pounds of refrigerant were salvaged from refrigerator and freezer units prior to recycling. Smaller amount of aluminum and iron were recycled as well.

Mississippi had less success in recycling electronics due to the damage and salt water inundation to many of the collected units. However, EPA and Best Buy teamed up with MDEQ and Jackson County to sponsor a collection event for damaged electronics.

MDEQ and EPA visited various industrial and commercial facilities to assess potential releases of hazardous constituents to the environment. The state was fortunate that these assessments did not reveal widespread release of hazardous materials. Releases that were identified were contained and addressed. HHW and similar waste from commercial businesses were segregated from nonhazardous debris at the point of initial collection, at staging sites, and then again at disposal sites. EPA was able to offer curbside collection of HHW in several areas.

Putrescible waste was another debris stream of concern. Mississippi had public health concerns about the tremendous amounts of food waste including poultry, bananas, and pork belly products at the state port in Gulfport and seafood products at the Pascagoula Port and at seafood industries along the Gulf Coast. This waste had to be collected and disposed of quickly to prevent public health problems resulting from the decomposing foods. In a few instances, the bulk food wastes were of such significant concern that MDEQ worked with EPA to dispose of the materials under the hazardous material management provisions. MDEQ also dealt with grocery and convenience stores along the coast that had suffered electricity outages and, in some instances, were flooded, leaving rotting and decaying food in the stores. MDEQ worked with store owners to develop plans for cleanout and disposal of their putrescible waste.

Household items, such as large appliances, lawn mowers, computers, and televisions, were also segregated in order to remove chemicals, heavy metals, and petroleum products. Generally, the bulkiness of these items makes proper compaction at landfills difficult to achieve. Proper compaction helps prevent the infiltration of rainwater into the landfill, reducing leachate generation and combustion potential within the landfill. Items that could not be recycled were sent to MSW landfills with constructed liner systems for disposal.

Mississippi has made a series of changes in response to problems in response and recovery efforts after Hurricane Katrina. The state received \$159 million to construct safe rooms and shelters for flooding, tornados, and hurricanes. Mississippi has also been working on hazard mitigation efforts including updating building codes, wind retrofits, increasing elevation for flood control, improving storm drainage, and implementing siren alert systems. MDEQ worked to evaluate and revise Emergency Debris Management policies and compile these policies with valuable experience from Hurricane Katrina into a debris management plan.

For more information on Hurricane Katrina debris management in Mississippi, see <https://archive.epa.gov/katrina/web/html/>.

Alstead, NH: Flooding 2005

In early October 2005, the western part of New Hampshire experienced intense rainfall and flooding. The area received approximately 12 inches of rainfall in a 30-hour period. Existing drainage networks were overwhelmed, leading to the failure of a road embankment. The

resulting 30-40 foot wall of water and debris discharged into the valley, causing damage to private property, destruction of homes and businesses, severe damage to infrastructure, extensive erosion, contamination of drinking water, loss of agricultural productivity, and four deaths. The flooding destroyed 36 buildings and damaged an additional 71 homes, and about 57 miles of roads were closed until they could be inspected by New Hampshire Department of Transportation teams. These teams examined bridges, steep slopes, and drainage infrastructure across the state. Alstead received nearly \$1 million from FEMA and state agencies for infrastructure repair and public damages.

Communication

After the flooding subsided, a command center was established in the Alstead Village Fire Station to coordinate between responders. UHF radios were one of the primary methods for interagency communication and organizing responders from local, state, and federal agencies. Neighboring towns sent equipment and personnel as part of New Hampshire's Mutual Aid program.

Alstead relied on local television, cell phones, and word of mouth (the small nature of the town made this possible) to inform residents of the magnitude of the flooding and about plans to collect debris.

Collection and Segregation

The town's community field became a temporary storage area for flood debris. Materials were sorted into separate piles of tires, wood, cars, metal, and trees. Trees were shredded into wood chips, and topsoil was recovered by screening the woody debris. In order to handle incoming disaster debris, existing facility permits were temporarily modified, including allowing the disposal of vegetative debris in landfills and exceedance of the annual/monthly disposal rates.

Emergency permits were issued for temporary facilities to collect, process, and dispose of debris. Proximity of the facilities to damaged structures and the main debris fields was a major factor in their siting. Pre-identification of sites in several locations would have benefited the town by providing time to secure the approval of private land owners, estimate site capacity and handling rates, and account for any archeological, historic, or environmental issues while providing locational flexibility that enables the community to choose the facility site most convenient to debris fields.

Joplin, MO: Tornado 2011

Joplin, Missouri was struck by a tornado on May 22, 2011 that was rated as a EF-5 on the Enhanced Fujita Scale with maximum winds of 200 mph. The path of the entire tornado was 22.1 miles long and was up to one mile in width. The tornado's most violent winds were observed as it traveled six miles through the central part of Joplin. The tornado displaced 14,000 people, injured thousands of residents, and caused 162 deaths. FEMA declared this tornado the single largest disaster ever to occur in the region. The tornado heavily damaged

8,000 structures, including the community's hospital, junior college, and eight local schools. The Joplin Tornado generated a total of three million cubic yards of debris throughout the disaster area and \$2.8 billion of damage. In the storm's aftermath, EPA conducted response operations working closely with partner agencies, primarily the USACE. EPA was allocated a total of \$6.025 million for the tornado response.

Communication

Communication with the public was a key aspect of Joplin's disaster cleanup plan. A week after the tornado, Joplin instructed the residents to segregate their waste on the curb into separate piles for vegetative debris, appliances, e-waste, household waste, and C&D debris. EPA prioritized communication, conducting more than 70 news media interviews as part of a public outreach strategy. Additionally, EPA worked with the City of Joplin to determine facilities for the collection, staging, and disposal of disaster debris.

Collection and Segregation

EPA, FEMA, USACE, the Missouri Department of Natural Resources, other partner agencies, and nongovernmental entities worked to reuse and recycle all recovered white goods, propane tanks, and other debris. EPA deferred to local jurisdictions for recycling information and activities. Joplin kept a significant amount of material out of landfills due to their preparedness and willingness to follow guidance from FEMA. The city already had policies in place to recycle metal, reuse vegetative debris, and manage HHW. All of these policies facilitated the city's disaster debris management efforts.

About 156 tons of e-waste and 257 tons of white goods were collected and recycled. A total of 28 appliances that were still functioning was donated to the local Habitat for Humanity. The majority of vegetative debris was ground into mulch, including over 400,000 yards of downed trees. Large amounts of C&D debris from destroyed buildings were also collected. For example, one building sustained such extensive damage that it had to be demolished and reconstructed; 17,000 tons of C&D debris from the original building were crushed on-site and used as base materials in the construction of its replacement.

Debris from Joplin was sent either to the Prairie View Municipal Solid Waste Landfill in Missouri or to landfills in Kansas. Roughly 230,000 tons (about 1.3 million cubic yards) of disaster debris were disposed of in landfills in Kansas, which constitutes more than one-third of the total debris generated by the tornado. The Kansas Department of Health and Environment offered support in distributing debris to three landfills. Due to the close proximity of the Kansas landfills to Joplin, Missouri, transportation costs were reduced.

New York City, NY: Hurricane Sandy 2012

Hurricane Sandy hit the coast of New York on October 29, 2012. Sandy caused 43 deaths, thousands of injuries, and generated approximately 700,000 tons of debris. City, state, and federal authorities cooperated in organizing emergency response efforts. The Office of the Mayor of New York City (NYC), NYC Emergency Management, NYC Department of

Sanitation (DSNY), NYC Department of Parks & Recreation, FEMA, and USACE all played critical roles in the emergency response efforts.

The President authorized a State of Emergency for New York before the arrival of Hurricane Sandy. Prior to the arrival of the storm, NYC established an Emergency Operations Center, communicated with the public through daily press briefings, and activated its Coastal Storm Plan to set up emergency facilities and evacuate residents from high-risk areas. The city also created the Downed Tree Task Force, which later became the NYC Debris Removal Task Force.

Communication

NYC communicated with the public through as many media outlets as possible, including television, radio, newspapers, and a variety of internet sources in multiple languages. The city also utilized the emergency update system to notify registered users of updates by text.

Collection and Segregation

The responding organizations, including USACE and DSNY, worked to recycle or dispose of the large quantities of debris. The debris included 22,000 cubic yards of vegetative debris, 110,000 containers of HHW and e-waste, 23,000 cubic yards of ACM, 1,200 tons of white goods, 10,000 cubic yards of concrete, 3,437 cars, and 72 boats. Additionally, over two million cubic yards of sand, which had been displaced from beaches, were collected, cleaned, and reused to create berms to improve protection from storm surges. The reuse of this sand saved NYC approximately \$270 per cubic yard in disposal costs and about \$80 per yard for new sand for restoration uses.

Due to the immediate concern of protecting human health and life, emergency responders chose to transfer debris to landfills and incinerate vegetative debris, overlooking recycling in favor of increasing the speed of debris removal. On November 27, NYC and USACE shifted from primarily focusing on quick incineration to using vegetative debris as fuel, mulch, and landfill cover. Incineration remained a contingency plan to mitigate risks of spontaneous combustion to vegetative debris piles.

Debris was collected at pre-assigned, state-licensed areas in Buffalo and Albany where debris streams were segregated and staged for disposal. New York was able to divert white goods, vehicles and vessels, e-waste, concrete, sand, exotic wood from boardwalks, and much of the vegetative debris from landfills. Remaining debris was transported to disposal sites by DSNY and USACE contractors.

New York City's Hurricane Sandy Debris Removal Task Force, which included 25 government agencies, was awarded the Green Star Award from the United Nations Office for the Coordination of Humanitarian Affairs, Green Cross International, and the United Nations Environment Program in recognition of the task force's efforts to prepare for and respond to the environmental disaster. Working through the challenges of highly limited space parameters, removing the large amounts of debris that had accumulated in undeveloped wetland areas, and

recycling large quantities of debris were all recognized as critical aspects of the response efforts.

The 2013 NYC Hurricane Sandy After Action Report is located at http://www.nyc.gov/html/recovery/downloads/pdf/sandy_aar_5.2.13.pdf, and FEMA's Hurricane Sandy After-Action Report is located at <https://www.fema.gov/media-library/assets/documents/33772>.

St. Louis Metro Area, MO: Floods 2015

The State of Missouri's governor declared a State of Emergency on December 27, 2015, due to historic and widespread flooding and destruction. The flooding caused at least fifteen deaths in Missouri and damaged approximately 7,100 buildings. The President declared a national State of Emergency on January 2, 2016. Missouri's Franklin, Jefferson, St. Charles, and St. Louis counties were among the most impacted areas.

Communication

Communication between EPA and state and local officials facilitated the establishment of sites for the collection, staging, and disposal of debris. In response to the flooding in the St. Louis Metro Area, EPA deployed a suite of mobile and web-based GIS technologies designed to provide federal On-Scene Coordinators, state partners, and regional managers with a common operational picture of the response. This incident was the first major incident where mobile collection devices were utilized; their use proved to be highly successful. The technologies also built on public outreach, providing information in a web-based forum. Engagement of the community was essential for debris segregation.

Collection and Segregation

EPA worked on emergency response and debris management activities in collaboration with FEMA and USACE, as well as state personnel, USACE specialists, and National Guard members. FEMA issued Mission Assignments to EPA to collect HHW, e-waste, orphaned containers, and C&D debris. (EPA does not typically lead the collection of C&D or other non-hazardous debris for the federal government.) With experience acquired from its work following other major natural disasters, including the Joplin tornado in 2011 and flooding in Iowa in 2008, EPA implemented its "lean and green" approach to help the residents of the St. Louis Metro Area recover as quickly as possible while minimizing costs to both taxpayers and the environment.

EPA operated a drop-off collection facility in Eureka, conducted aerial assessments to identify affected areas and locate flood debris, and deployed boats to collect various orphaned containers and debris from lakes, streams, and shorelines. The Eureka facility was identified as a staging site for HHW because it fell outside the floodplain. After the conclusion of most of the recovery efforts, a small EPA team remained to assist community volunteers in a final effort to collect remaining debris and close out the agency's response operations.

EPA and its contractors collected debris and hazardous materials during a two-month period. HHW that had been collected at curbsides, as well as orphaned containers like drums, tanks,

fluid totes, and canisters that were found floating in or washed up near waterways, were gathered at EPA's staging area near Eureka. Crews sorted and grouped items by type prior to shipping them off for processing and disposal at approved hazardous waste facilities. Hazardous components, including refrigerants, were safely captured and stripped from discarded refrigerators and freezers so that they and other discarded major appliances could be recycled for scrap metal through a private firm. Use of this local firm minimized time, transportation costs, and environmental impacts. Instead of being sent to a landfill, e-waste and similar items, including televisions, computer equipment, lamps, small appliances, and stereos, were sent to the American Military Veterans Assistance Corporation in St. Louis, which is a local, non-profit community organization that specializes in the recycling of these items. About 317 drums, 20,852 assorted small containers, 112 large containers, 179 propane tanks, 266 compressed gas tanks, 1,032 units of white goods, 403 batteries, 177 small engines, and 6,037 electronic items were collected.

Over 22,000 cubic yards of residential flood debris, including 8,913 cubic yards of sandbag debris and 13,500 cubic yards of vegetative debris, were collected and removed. Large quantities of vegetative debris were ground into mulch for landscaping and soil conditioning purposes. EPA also handled the collection and disposal of 1,310 tons (2,620,000 pounds) of sandbags. C&D debris removed from damaged structures could not be recycled because of excessive exposure to water and sediment. Instead, C&D debris from residential areas was sent to two local landfills. Once again, the close location of debris disposal sites to debris sources reduced transportation costs and saved time.

4 Examples of Debris Management Plans and Guidance

The following documents are examples of how state and local governments have planned for disaster debris management. These plans and guidance documents have not been reviewed or endorsed by EPA and are only intended to serve as a resource for planners. Additional plans and guidance are available. For example, although they are not specific to natural disaster debris management, the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) lists state solid waste management plans at http://www.astswmo.org/Files/Policies_and_Publications/Solid_Waste/2009-09-State-SW-Management-Plans-Reference-Sheet.pdf. Also, many states' emergency response plans for marine debris can be found on NOAA's MDP's website at <https://marinedebris.noaa.gov/reports-and-technical-memos>.

4.1 State Plans and Guidance

California Governor's Office of Emergency Services

"Debris Management" Homepage

<http://www.caloes.ca.gov/cal-oes-divisions/recovery/disaster-mitigation-technical-support/technical-assistance/debris-management>

Connecticut Department of Energy and Environmental Protection

"Disaster Debris Management Plan," June 2013

http://www.ct.gov/deep/cwp/view.asp?a=2718&Q=410492&deepNav_GID=1646#Plans

Florida Division of Emergency Management

"Debris Management" Homepage

<http://archive.floridadisaster.org/Recovery/DSCP/debris/debris.html>

Georgia Emergency Management & Homeland Security Agency

"Debris Management Annex," 2006

[http://www.gema.ga.gov/Plan%20Library/Debris%20Management%20Annex%20\(2006\).pdf](http://www.gema.ga.gov/Plan%20Library/Debris%20Management%20Annex%20(2006).pdf)

Louisiana Department of Environmental Quality

"Comprehensive Plan for Disaster Clean-up and Debris Management," March 2018

<http://deq.louisiana.gov/resources/category/debris-management>

Massachusetts Department of Environmental Protection

"All Hazards Disaster Debris Management Plan," February 2014

<https://www.mass.gov/lists/massdep-solid-waste-policies-guidance-fact-sheets>

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New Jersey Department of Environmental Protection

“Disaster Debris Management Planning Tool Kit for New Jersey Municipalities,” November 2015

<http://www.state.nj.us/dep/dshw/toolkit.pdf>

New York State Department of Environmental Conservation

“Disaster Debris Management Planning: Tool Kit for New York State Municipalities”

<http://www.dec.ny.gov/regulations/8751.html>

Ohio Emergency Management Agency

“Debris Management” Homepage

http://ema.ohio.gov/Recovery_DebrisInfo.aspx

Oklahoma Department of Environmental Quality

“Storm Debris Information” Section

<http://www.deq.state.ok.us/lpdnew/swindex.html>

4.2 City and County Plans

Coral Springs, Florida

“Debris Management Plan,” July 2014

<http://www.coral springs.org/Home/ShowDocument?id=3114>

Franklin County, Massachusetts

“Disaster Debris Management Plan,” December 2014

<http://frcog.org/publication/view/franklin-county-disaster-debris-management-plan/>

Nassau County, New York

“Disaster Debris Management Plan”

<https://www.nassaucountyny.gov/DocumentCenter/View/6398>

Iredell County, North Carolina

“Debris Management: Iredell County Emergency Operations Plan,” May 2012

<https://www.co.iredell.nc.us/DocumentCenter/View/582>

Portland, Oregon

“Disaster Debris Management Annex,” January 2014

<https://www.portlandoregon.gov/pbem/article/480555>

Houston, Texas

“Annex W - Debris Management,” April 2013

<http://www.houstonoem.org/plans-programs/>

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Appendix A: Tools and Resources

Community Resiliency and Planning:

1. FEMA's Best Practices and Case Studies Portfolio – shares stories on effective mitigation strategies and practices (<https://www.fema.gov/mitigation-best-practices-portfolio>). These mitigation best practices are part of FEMA's Safer, Stronger, Protected Homes & Communities website that provides in-depth information on techniques for building disaster-resistant structures (<https://www.fema.gov/safer-stronger-protected-homes-communities>).
2. USACE's Building Resilience website – contains information on building-related resources, including design criteria, new technologies, and building codes (<http://www.usace.army.mil/Missions/Sustainability/Building-Resilience/>).
3. NOAA and EPA's CAMEO Software Suite – consists of four core programs- CAMEOfm, CAMEO Chemicals, ALOHA, and MARPLOT- that help officials plan for and respond to chemical emergencies (<http://response.restoration.noaa.gov/cameosuite>; <https://www.epa.gov/cameo>).
4. DOE's Climate Change and the Electricity Sector: Guide for Climate Change Resilience Planning (September 2016) – provides basic assistance to electric utilities and other stakeholders in assessing vulnerabilities to climate change and extreme weather and in identifying an appropriate portfolio of resilience solutions (https://energy.gov/sites/prod/files/2016/10/f33/Climate%20Change%20and%20the%20Electricity%20Sector%20Guide%20for%20Climate%20Change%20Resilience%20Planning%20September%202016_0.pdf).
5. U.S. Fish & Wildlife Service's (FWS's) Critical Habitat for Threatened & Endangered Species – maps a non-exhaustive list of designated critical habitat in the U.S. (<https://fws.maps.arcgis.com/home/item.html?id=9d8de5e265ad4fe09893cf75b8dbfb77>).
6. USDA's Natural Resources Conservation Service's Cultural Resources website – links to information related to the protection of historic and cultural resources (<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/ecoscience/cultural/>).
7. FEMA's Debris Management Plan Job Aid – provides instructions on creating a Debris Management Plan. The Job Aid can be found in Appendix D of FEMA's "Public Assistance Program and Policy Guide" (<https://www.fema.gov/media-library/assets/documents/111781>).
8. Congressional Research Service's Disaster Debris Management: Requirements, Challenges, and Federal Agency Roles (September 6, 2017) – provides information on the requirements applicable to disaster debris management, the challenges that

communities face when managing disaster debris, and the types of support provided by FEMA, USACE, and EPA with respect to disaster debris removal (<https://fas.org/sgp/crs/homesecc/R44941.pdf>).

9. USDA's Disaster Planning website – links to resources on disaster planning and preparedness for animals (<https://www.nal.usda.gov/awic/disaster-planning>).
10. EPA's Enforcement and Compliance History Online (ECHO) website – allows about 800,000 regulated facilities nationwide to be searched for downloadable information on permit data, inspection dates and findings, violations, enforcement actions, and penalties assessed (<https://echo.epa.gov/>).
11. NOAA's Environmental Response Management Application (ERMA) – uses an online mapping tool that integrates both static and real-time data, such as Environmental Sensitivity Index (ESI) maps, ship locations, weather, and ocean currents, to aid environmental responders and decision makers in spill preparedness and planning and coordinating emergency response efforts and situational awareness for disasters (<https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma>).
12. EPA's Harmful Materials and Residential Demolition website – lists many harmful materials that may be found in debris from residential property (<https://www.epa.gov/large-scale-residential-demolition/harmful-materials-and-residential-demolition>).
13. FEMA's Hazard Mitigation Planning website – provides an overview and other information on hazard mitigation planning for state, local, and tribal officials and members of the public (<https://www.fema.gov/hazard-mitigation-planning>).
14. EPA's Managing Materials and Wastes for Homeland Security Incidents website – provides all-hazard planning information to improve community resiliency and considerations for waste management decisions (<https://www.epa.gov/homeland-security-waste>).
15. NOAA's Marine Debris Program website – contains many resources for marine debris, including states' emergency response and reduction plans for marine debris and reports on prevention projects and best management practices (<https://marinedebris.noaa.gov/reports-and-technical-memos>).
16. EPA's Materials Management Wizard (MWiz) – provides a repository of EPA-sourced materials management tools and resources to support and promote sustainable materials management and community planning (<https://www.epa.gov/sustainability/mwiz>).

17. FEMA's Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards – identifies mitigation opportunities and strategies for improving community resiliency to a variety of disasters (<https://www.fema.gov/media-library/assets/documents/30627>).
18. National Climate Assessment (2014) – contains detailed information on climate change impacts on the U.S., as well as mitigation and adaptation strategies (<http://nca2014.globalchange.gov/>).
19. EPA's National Stormwater Calculator – estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States (including Puerto Rico). Estimates are based on local soil conditions, land cover, and historic rainfall records (<https://www.epa.gov/water-research/national-stormwater-calculator>).
20. U.S. FWS National Wetlands Inventory (NWI) – provides detailed information, including characteristics and locations, of U.S. wetlands (<https://www.fws.gov/wetlands/>).
21. The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings – provide a framework and guidance for decision-making about work or changes to a historic property (<https://www.nps.gov/tps/standards.htm>).
22. U.S. Climate Resilience Toolkit – assists with understanding climate threats and vulnerabilities, options, and planning actions (<https://toolkit.climate.gov/>).

Debris Forecasting:

1. USACE's Disaster Impact Models – provide estimates of quantities of debris volumes, probable people impacted, and housing needs for hurricanes (<http://www.usace.army.mil/Missions/Emergency-Operations/Disaster-Impact-Models/>).
2. FEMA's Hazards U.S. Multi-Hazard (Hazus-MH) – provides estimates of potential losses from disasters through GIS and access to databases including hazard data, boundary map data, and a proxy for the general building stock information, as well as data on important and high-risk facilities, agriculture, vehicles, and demographics (<https://www.fema.gov/hazus>).
3. EPA's Incident Waste Decision Support Tool (I-WASTE) – organizes large amounts of information related to managing waste resulting from incidents of national significance (e.g., contaminated buildings and natural disasters). The tool provides access to technical information, regulations, and guidance to help work through important waste management issues. Capabilities for I-WASTE include creating an incident plan or response record, estimating waste material, and accessing treatment and disposal facility

databases and relevant documents (registration required)
(<http://www2.ergweb.com/bdrtool/login.asp>).

Debris Management Facilities:

1. BMRA's building materials website – includes a searchable business directory for deconstruction services, recycling centers, and reuse stores, among others (<https://bmra.org/>).
2. CDRA's C&D recycling website – includes a searchable list of recyclers for C&D materials, such as concrete, asphalt, asphalt shingles, gypsum wallboard, wood, and metals (<https://cdrecycling.org/directory/>).
3. Whole Building Design Guide's Construction Waste Management Database – provides information on companies that accept recyclable construction debris (<http://www.wbdg.org/additional-resources/tools/construction-waste-management-database>).
4. Council of Industrial Boiler Owners' website – provides assistance in locating an industrial boiler that can take biomass generated from a disaster (<https://www.cibo.org/>).
5. EPA's Disaster Debris Recovery Database – uses an interactive map to provide information and locations of 12 types of recyclers and landfills (over 6,000 facilities) throughout EPA Region 5 (IL, IN, MI, MN, OH, WI) and surrounding states that are capable of managing different debris streams (<https://www.epa.gov/large-scale-residential-demolition/disaster-debris-recovery-database>).
6. Telecommunications Industry Association's E-cycling Central – provides a list of reuse, recycling, and donation programs for electronics for each state (<http://www.eiae.org>).
7. e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment website – includes a searchable directory of electronics recyclers (<http://e-stewards.org/>).
8. Energy Recovery Council's website – includes a directory of waste-to-energy facilities (<http://energyrecoverycouncil.org/>).
9. BioCycle's Find a Composter.com – allows users to search for composters, anaerobic digesters, and organics collection services (<http://www.findacomposter.com/>).
10. EPA's Incident Waste Decision Support Tool (I-WASTE) – provides a searchable list of treatment and disposal facilities, a downloadable KMZ file with the same geolocated facilities suitable for incorporation into GIS visualization and analysis, and useful resources on recycling various materials (registration required) (<http://www2.ergweb.com/bdrtool/login.asp>).

11. EPA's Responsible Appliance Disposal (RAD) website – contains a searchable list of responsible recyclers of certain white goods (i.e., refrigerated appliances, such as refrigerators, freezers, window air-conditioning units, and dehumidifiers) (<https://www.epa.gov/rad>).
12. Sustainable Electronics Recycling International's Responsible Recycling (R2) Standard for Electronics Recyclers website – contains a searchable database on electronics recycling and refurbishing facilities (<https://sustainableelectronics.org/>).

Disaster-specific Information:

1. FLASH's #HurricaneStrong – offers hurricane safety and mitigation information to prevent hurricane damage to homes (HURRICANES) (<http://www.flash.org/hurricanestrong/>).
2. FEMA's Flood Map Service Center – provides tools to understand an area's flood risk (FLOODS) (<https://msc.fema.gov/portal/>).
3. USGS's Geospatial Multi-agency Coordination (GeoMAC) tool – provides maps of current fire locations and perimeters in the U.S. (WILDFIRES) (<https://www.geomac.gov/about.shtml>).
4. FEMA's National Flood Insurance Program – aims to reduce the impact of flooding on private and public structures by providing affordable insurance to property owners and by encouraging communities to adopt and enforce floodplain management regulations (FLOODS) (<https://www.fema.gov/national-flood-insurance-program>).
5. FEMA's National Flood Insurance Program: Flood Hazard Mapping – identifies major flood risks and provides data for mitigation efforts (FLOODS) (<https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>).
6. NOAA's National Hurricane Center and Central Pacific Hurricane Center – provide forecasts and warnings for tropical cyclones in the Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and Eastern and Central Pacific Ocean (HURRICANES) (<http://www.nhc.noaa.gov/>; <http://www.prh.noaa.gov/cphc/>).
7. NOAA's Office of Water Prediction – collaboratively researches, develops, and delivers state-of-the-science national hydrologic analyses, forecast information, data, decision-support services, and guidance to support and inform essential emergency services and water management decisions (FLOODS) (<http://water.noaa.gov/>; <http://water.weather.gov/ahps/>).
8. FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program – works with federal, state, local, and tribal partners across the U.S. to identify flood risk and help reduce that risk by providing high quality flood maps and information, tools to better

assess the risk from flooding, and planning and outreach support to communities to help them take action to reduce (or mitigate) flood risk (FLOODS) (<https://www.fema.gov/risk-mapping-assessment-and-planning-risk-map>).

9. USGS's Seismic Hazard Maps and Site-Specific Data website – maintains seismic hazard maps that provide the most up-to-date information on earthquakes (EARTHQUAKES) (<https://earthquake.usgs.gov/hazards/hazmaps/>).
10. NOAA's U.S. Tornado Climatology website – provides data on the average number of tornadoes by state over a 20-year period (TORNADOES) (<https://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology>).
11. NOAA's U.S. Tornado Outbreak Interface – displays meteorological and tornado track data for violent tornado events, including outlooks, watches, observed soundings, radar loops, satellite images, and surface observations, and provides annual tornado track data, climatology information, and an index of tornado event weblinks (TORNADOES) (<http://www.spc.noaa.gov/exper/outbreaks/>).
12. NOAA's U.S. Tsunami Warning System and Pacific Tsunami Warning Center – provide forecasts and warnings for tsunami threats for the U.S. and some international partners (TSUNAMIS) (<https://tsunami.gov/>; <http://ptwc.weather.gov/>).
13. USGS's Volcano Hazards Program – provides forecasts, warnings, and information for volcano hazards (VOLCANOES) (<https://volcanoes.usgs.gov/index.html>).

Federal Disaster Assistance:

1. FEMA's Alternative Procedures website – describes the public assistance alternative procedures pilot programs for emergency work (debris removal) and permanent work (repair, restoration, and replacement of disaster-damaged public and private nonprofit facilities) (<http://www.fema.gov/alternative-procedures>).
2. NOAA's Community-based Marine Debris Removal Grants – support locally driven, community-based marine debris prevention and removal projects (<https://marinedebris.noaa.gov/about-us/funding>).
3. HUD's Community Development Block Grant Disaster Recovery grants – provide assistance to communities to help them recover from presidentially declared disasters. Awards are typically made to states or local governments, as authorized by Congress (<https://www.hudexchange.info/programs/cdbg-dr/>).
4. USDA's Disaster Resource Center – provides a searchable database that contains disaster-related resources, as well as information on USDA disaster assistance programs (<http://www.usda.gov/wps/portal/usda/usdahome?navid=disaster-help>).

5. HUD's Disaster Response Toolkit – aids homeowners and property owners in the disaster recovery process and includes guidance on how to rehabilitate flooded homes, design and construction practices that promote moisture resistance and durability, and preparedness for future disasters (<https://www.huduser.gov/portal/disaster-recovery.html>).
6. USACE's Emergency Operations website – includes information on disaster debris management assistance from the USACE (<http://www.usace.army.mil/Missions/Emergency-Operations/National-Response-Framework/>).
7. FHWA's Emergency Relief for Federally Owned Roads Program – assists federal agencies with the repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel (<https://flh.fhwa.dot.gov/programs/erfol/>).
8. FHWA's Emergency Relief Program – assists in the repair of federal roads that have suffered serious, widespread damage because of natural disasters (<http://www.fhwa.dot.gov/programadmin/erelief.cfm>).
9. FEMA's Hazard Mitigation Assistance website – provides general information on hazard mitigation and the Hazard Mitigation Assistance (HMA) grant programs (the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance (FMA) Program, and the Pre-Disaster Mitigation (PDM) Program) (<https://www.fema.gov/hazard-mitigation-assistance>).
10. FEMA's Procurement Disaster Assistance Team – helps PA recipients comply with federal procurement standards (<https://www.fema.gov/procurement-disaster-assistance-team>).
11. FEMA's Public Assistance Program and Policy Guide – provides an overview of the Public Assistance Program available to state, local, tribal, and territorial governments after a presidential disaster declaration (<https://www.fema.gov/media-library/assets/documents/111781>).
12. NOAA's Sea Grant Programs – help communities effectively plan for, respond to, and recover from natural disasters (<http://seagrant.noaa.gov/Our-Work/RCE>).
13. The System for Award Management website – provides a searchable record of entities able to do business with the federal government, as well as entities excluded from federal contracts. Also, communities can use the Disaster Response Registry to find contractors willing to provide debris removal and other disaster relief supplies and services during a natural disaster (<https://sam.gov/portal>).

Health and Safety

1. OSHA's Hurricane eMatrix – provides information on hazards to response and recovery workers after a hurricane (<https://www.osha.gov/SLTC/etools/hurricane/index.html>).

Homeland Security Documents:

1. FEMA's Disaster Declaration Process website – details how to request federal assistance under the Stafford Act (<https://www.fema.gov/disaster-declaration-process>).
2. National Disaster Recovery Framework – describes context for how the whole community works together to restore, redevelop and revitalize the community following a disaster (<https://www.fema.gov/national-disaster-recovery-framework>).
3. National Mitigation Framework – addresses how the whole community will develop, employ, and coordinate mitigation capabilities to reduce loss of life and property by lessening the impact of disasters (<https://www.fema.gov/media-library/assets/documents/32209>).
4. National Preparedness Goal 2nd Edition (2015) – describes the vision for preparedness nationwide and identifies the core capabilities necessary to achieve that vision across five mission areas (i.e., Prevention, Protection, Mitigation, Response and Recovery) (<https://www.fema.gov/media-library/assets/documents/25959>).
5. National Response Framework – maps out a uniform federal response to help the whole community prepare for, respond to, and recover from a disaster or other incident (<https://www.fema.gov/media-library/assets/documents/32230>).

Training:

1. FEMA's Emergency Management Institute (EMI) – offers emergency management training (e.g., debris management, incident command, recovery operations, mitigation) to enhance the capabilities of federal, state, local, and tribal government officials and the public and private sectors to minimize the impact of disasters and emergencies on the American public (<http://training.fema.gov>).

Transportation Options:

1. DOE's Transportation Routing Analysis Geographic Information System (TRAGIS) – analyzes highway, rail, or waterway transportation routes and alternatives within the United States (<https://webtragsis.ornl.gov/tragsis/app/login>).

Waste Management Information:

1. NOAA's Abandoned and Derelict Vessels InfoHub – serves as a central source of information for each coastal state's policies on abandoned and derelict vessels, including

state-specific removal and disposal requirements and guidelines

(<https://marinedebris.noaa.gov/discover-issue/types-and-sources/abandoned-and-derelict-vessels>).

2. National Response Team's Abandoned Vessel Authorities and Best Practices Guidance (2014) – includes information on options for removal and ultimate disposition of abandoned vessels (<https://www.nrt.org/Main/Resources.aspx?ResourceType=Abandoned%20Vessels&ResourceSection=2>).
3. EPA's Anaerobic Digestion website – provides information on anaerobic digestion, including its environmental benefits (<https://www.epa.gov/anaerobic-digestion>).
4. EPA's Asbestos website – provides general and management information on asbestos, including information on the federal requirements for the renovation and demolition of buildings that contain asbestos (<https://www.epa.gov/asbestos>).
5. Asphalt Recycling & Reclaiming Association website – provides information on recycling asphalt (<http://www.arra.org/>).
6. Automotive Recyclers Association's website – includes information on the reuse and recycling of automotive parts (<http://www.a-r-a.org>).
7. EPA's Best Management Practices to Prevent and Control Hydrogen Sulfide (H₂S) and Reduced Sulfur Compound Emissions at Landfills That Dispose of Gypsum Drywall report – provides regulatory agencies, landfill owners and operators, and other interested parties with information regarding the science of H₂S production and emissions at landfill sites and information on best management practices to prevent and control these emissions (<https://nepis.epa.gov/Adobe/PDF/P100NG53.pdf>).
8. CDRA's C&D recycling website – contains information on recycling asphalt shingles, concrete, and gypsum drywall (<http://www.cdrecycling.org/>).
9. EPA's Choosing a Responsible Recycler: A Guide for Generators of Secondary Hazardous Materials – is a two-page guide for choosing a responsible recycler of hazardous waste and hazardous secondary materials, the basic principles of which may be applicable to other debris streams (<https://www.epa.gov/hwgenerators/choosing-responsible-recycler-guide-generators-secondary-hazardous-materials>).
10. Construction Industry Compliance Assistance Center's website – provides compliance information for the construction industry (<http://www.cicacenter.org>).
11. EPA's Guidance for Catastrophic Emergency Situations Involving Asbestos – discusses federal asbestos regulations, the types of asbestos issues that may arise during catastrophic events, and how EPA has addressed such issues (<https://www.epa.gov/large->

[scale-residential-demolition/guidance-catastrophic-emergency-situations-involving-asbestos](#)).

12. EPA's [Hazardous Waste website](#) – provides information on the federal regulations that apply to hazardous waste management (<https://www.epa.gov/hw>).
13. EPA's [Identification of Non-Hazardous Secondary Materials That Are Solid Waste website](#) – provides information on the NHSM regulations, which may affect the management of disaster debris (<https://www.epa.gov/rcra/identification-non-hazardous-secondary-materials-are-solid-waste>).
14. EPA's [Industrial Uses for Wasted Food website](#) – shares information on obtaining biofuel and bio-products from wasted food, including fats, oil, and grease (<https://www.epa.gov/sustainable-management-food/industrial-uses-wasted-food>).
15. [Institute of Scrap Recycling Industries' website](#) – provides information on recycling scrap commodities, including ferrous and nonferrous metals, paper, electronics, rubber, plastics, glass, and textiles (<http://www.isri.org>).
16. EPA's [Links to Hazardous Waste Programs and U.S. State Environmental Agencies website](#) – lists websites for states' solid and hazardous waste programs and environmental agencies (<https://www.epa.gov/hwgenerators/links-hazardous-waste-programs-and-us-state-environmental-agencies>).
17. EPA's [Managing Materials and Wastes for Homeland Security Incidents website](#) – provides public and private emergency planners, managers and responders with waste management information for all hazards (<https://www.epa.gov/homeland-security-waste>).
18. [National Demolition Association's website](#) – contains demolition-related information, including resources on disaster response (<http://www.demolitionassociation.com>).
19. [National Renderers Association's website](#) – contains information on rendering animal products (<http://www.nationalrenderers.org/>).
20. EPA's [Planning for Polychlorinated Biphenyl \(PCB\)-containing Disaster Debris \(June 2011\) guidance](#) – contains detailed information on the management of PCB-containing disaster debris in emergency situations that arise from natural disasters (<https://www.epa.gov/homeland-security-waste/guidance-about-planning-polychlorinated-biphenyl-containing-disaster-debris>).
21. EPA's [Polychlorinated Biphenyls \(PCBs\) website](#) – contains PCB management and other information, including a searchable list of disposal facilities and approvals that can be sorted by technology type and EPA Regional Office (<https://www.epa.gov/pcbs>).

22. EPA's RCRA Online tool – provides access to an extensive database of EPA interpretations of the RCRA regulations governing the management of solid, hazardous, and medical waste. (<https://www.epa.gov/rcra>).
23. Research on the Environmental Impacts of Treated Wood – contains information about CCA-treated wood (<http://www.ccaresearch.org>).
24. EPA's State Demolition Information website – lists state-by-state contact information about programs that relate to large-scale residential demolition (<https://www.epa.gov/large-scale-residential-demolition/state-demolition-information#main-content>).
25. EPA's Stationary Refrigeration and Air Conditioning website – contains information on the safe disposal of refrigerant-containing appliances (<https://www.epa.gov/section608>).
26. Steel Recycling Institute's website – contains information on recycling steel (<http://www.recycle-steel.org>).
27. EPA's Sustainable Management of Construction and Demolition Materials' website – shares information about the reuse and recycling of C&D materials (<https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials>).
28. EPA's Underground Storage Tanks (USTs) website – contains information on USTs, including preventing, detecting, and cleaning up releases (<https://www.epa.gov/ust>).
29. U.S. Composting Council's website – includes information on the management and potential end uses of vegetative debris (<http://www.compostingcouncil.org>).
30. WBUG's Woody Biomass Utilization website – provides tools and resources on woody biomass and vegetative debris utilization, including success stories (https://www.forestsandangelands.gov/Woody_Biomass/index.shtml).

Appendix B: Pre-incident Debris Management Plan Outline

This outline describes the “table of contents” of a typical pre-incident debris or waste management plan (WMP). The column on the left specifies the information to be included in a WMP, while the column on the right describes various issues that should be considered when developing each section of the plan to maximize its benefit during an actual incident. The column on the right also provides links to tools and resources that may aid in the development of the pre-incident WMP, as well as tips on adapting the pre-incident plan to an incident-specific plan after an actual incident occurs. The plan contents and list of considerations are not exhaustive and are not intended to be prescriptive. Instead, this outline is intended to be a starting point to aid in developing a pre-incident WMP. Information in one section may apply to other sections. The final organization and contents of a pre-incident WMP are entirely up to emergency managers and planners. Keep in mind that, when applicable, the National Response Framework¹ will guide a response to an incident and, thus, should be considered when developing a plan.

This outline assumes an all-hazards pre-incident WMP. Much of the information in a WMP is applicable to any scenario. However, scenario- and agent-specific information should also be developed to the extent possible and included in an all-hazards plan. This information may be incorporated as additional sub-headings within each section or as a series of appendices to the WMP.

Recommended Plan Contents:	Considerations:
<p>I. Plan Overview</p> <ol style="list-style-type: none"> 1. Scope <i>Scenario and entity covered</i> 2. Planning assumptions 3. List of officials who should be notified in the case of an incident 4. Roles and responsibilities <i>Include specialized resources (e.g., subject matter experts for consultation, emergency response teams)</i> 5. Regulatory requirements 6. Record of plan reviews and updates to include any changes made 	<p>This section should be updated as needed during an incident with the situational overview.</p> <p>Scenarios may be based on site- and community-specific threats, hazards, and vulnerabilities.²</p> <p>Include relevant federal, state, local, tribal, and territorial (including neighboring countries, as appropriate) environmental/public health regulatory and legal requirements that impact waste management and material reuse. Also, include the impact that a federal emergency or major disaster declaration might have on the implementation of applicable laws. Keep in mind that state requirements may be more stringent than federal requirements and may include additional waste streams not covered under federal laws.</p>

¹ <https://www.fema.gov/media-library/assets/documents/117791>

² See the Department of Homeland Security’s Comprehensive Preparedness Guide 201: Threat and Hazard Identification and Risk Assessment Guide at <https://www.fema.gov/media-library/assets/documents/26335>.

	<p>Establish roles and responsibilities for all waste management activities, including who will monitor contractors and waste management sites.</p>
<p>II. Materials and Waste Streams</p> <ol style="list-style-type: none"> 1. List of anticipated waste streams 2. Description of each waste stream <i>Include regulatory status (federal and state), associated hazards if any, agent-specific (e.g., chemical, biological) information, fact sheets if any, contact information for waste-specific subject matter experts, and packaging, labeling, handling, and transportation requirements, as well as identify decontamination and reuse, recycling, treatment, and disposal options appropriate to that waste stream</i> 	<p>This section should be updated as needed during an incident with the actual waste streams generated by the incident.</p> <p>Consider these and other potential waste streams:</p> <ul style="list-style-type: none"> • Ammunition and Explosives • Animal Carcasses • Aqueous Waste (e.g., water from decontamination activities) • Asbestos-containing Material • Asphalt • Biological-contaminated Waste • Building Contents • Chemically-contaminated Waste • Commingled Debris • Construction and Demolition Debris • Cylinders and Tanks • Electronics Waste • Food Waste • Hazardous Waste • Household Hazardous Waste • Marine or Waterway Debris • Metals • Mixed Waste • Municipal Solid Waste (MSW) • Pharmaceuticals • Polychlorinated Biphenyl (PCB)-containing Waste • Radiological-contaminated Waste • Regulated Medical Waste • Soils, Sediments, and Sandbags • Solid Waste from Response Activities (e.g., personal protective equipment (PPE), waste from law enforcement activities) • Treated Biological-contaminated Waste • Treated Chemically-contaminated Waste • Treated Radiological-contaminated Waste • Treated Wood • Used Oil and Oil-contaminated Waste • Vegetative Debris • Vehicles and Vessels • White Goods (i.e., household appliances)

<p>III. Waste Quantities</p> <ol style="list-style-type: none">1. Forecast quantity of each type of anticipated waste2. Method for estimating actual waste quantities during/after an incident <i>(e.g., GIS, windshield assessment, manned and unmanned aerial surveillance)</i>	<p>This section should be updated as needed during an incident with waste estimates based on the specifics of the incident.</p> <p>Recommended Tools:</p> <p>Incident Waste Decision Support Tool (I-WASTE DST) (registration is required to use this tool) http://www2.ergweb.com/bdrtool/login.asp</p> <p>FEMA’s Hazards U.S.-Multi-Hazard (Hazus-MH) (for estimating potential losses from earthquakes, floods, and hurricanes) http://www.fema.gov/hazus (ArcGIS software is required to use Hazus-MH)</p> <p>EPA’s Waste Estimation Support Tool (WEST) (for estimating the type and amount of waste generated from cleanup after a radiological incident) https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=288802</p>
<p>IV. Waste Characterization Sampling and Analysis <i>(for each waste stream)</i></p> <ol style="list-style-type: none">1. Sampling <i>Estimate number of samples, identify type of analysis needed for each waste/material type, potential approaches to combine/composite samples, and address Health and Safety issues, such as appropriate PPE for sampling activities AND Identify any requirements for transporting the samples to laboratories for testing (e.g., U.S. Department of Transportation (DOT), Centers for Disease Control and Prevention, Department of Energy, U.S. Department of Agriculture)</i>2. Analysis <i>Identify data quality objectives, labs which can conduct the analyses, as well as methodologies for the</i>	<p>Two different types of sampling may be needed to meet waste acceptance criteria at waste management facilities and to allay community concerns:</p> <ol style="list-style-type: none">1) sampling to classify and determine compliance with federal, state, local, or tribal regulatory criteria, and2) sampling to ensure that waste/materials have been effectively decontaminated. <p>Environmental Justice and other community concerns may make it advisable to conduct testing even when it is not legally required or conduct additional sampling and analysis in order to ensure transparency. As this may be cost-prohibitive, an alternative may be managing all waste as hazardous waste under RCRA. The relative costs/benefits should be evaluated, such as available capacity at laboratories and waste management facilities.</p> <p>Lab selection considerations include capacity, capability, access, cost, time needed to produce results, and anticipated community concerns.</p> <p>Lab analysis is often a bottleneck in an incident response. Labs will be involved in sampling for characterization and clearance of the incident location; therefore, consider sampling strategies in advance to limit the number of samples analyzed, if possible.</p>

<p><i>analyses, what items are needed for sampling (e.g., swabs, sample bottles), sampling methodologies (e.g., composite sampling procedures), and the required techniques</i></p> <p>3. Quality assurance <i>Identify methods to ensure the quality of the data, analysis, and results</i></p>	
<p>V. Waste Management Strategies/Options</p> <p>1. General principles <i>By activity</i></p> <ul style="list-style-type: none"> a. Minimization (actions to minimize waste generation, toxicity, and physical size) b. Collection (procedures; health and safety requirements) c. Segregation (procedures) d. Decontamination (people, equipment, waste/materials; health and safety requirements) e. Accumulation/Storage (site location selection criteria; documentation; health and safety requirements) <p>2. Pre-selected waste management sites <i>Site-specific information</i></p> <ul style="list-style-type: none"> a. Waste staging and storage (short-term and long-term) locations b. Equipment staging and storage (short-term and long-term) locations c. Decontamination and treatment stations 	<p>This section should be updated as needed during an incident (e.g., with sites that are used or may be used to manage waste during the incident).</p> <p>Relevant legal and regulatory requirements should be considered.</p> <p>Reuse, recycling, and composting are generally preferred options, where appropriate. Consider adding a list of possible materials that can be reused, recycled, or composted. Having advance information on the local and regional markets, capacity, and local and regional recyclers can be important.</p> <p>Consider the impact of potential decontamination approaches on quantities and characteristics of waste and the impact of waste management constraints on potential decontamination approaches.</p> <p>Consider difficulties and issues regarding removing waste from private property, waterways, and sensitive habitats (e.g., shorelines, wetlands, marshes) and their impacts on collection and removal activities.</p> <p>Account for impacts from adverse weather, such as flooding and wind damage.</p> <p>Identify multiple sites/locations to choose from during an incident, if possible. However, designating specific sites/locations in advance of an incident may not be possible. In this case, develop guidelines that could be used to designate sites during an incident.</p> <p>Whether specifying sites/locations or developing guidelines, consider:</p>

- Benefits of on-site vs. off-site management
- Potential impact of having to transport the waste
- Speed with which waste needs to be managed
- Facility requirements and capacity
- Permitting procedures
- Cost of various options
- Community/Environmental Justice concerns
- Site security
- Resources needed, including private sources of equipment
- FEMA's eligibility requirements
- Proximity to anticipated waste generation points
- Ease of access
- Ease of containment of wastes/materials
- Ownership of sites
- Need for buffers and setbacks
- Proximity to sensitive/protected areas (e.g., wetlands, surface water, storm drains and sanitary sewer drains that may lead to waterways, drinking water wells)
- Environmental and human health concerns of specific waste streams
- Ability to sort waste streams by category to facilitate recycling
- Ability to properly contain radioactive or other highly hazardous waste streams

Consider the possible need for long-term groundwater, air, and other environmental monitoring at on-site burial sites and other waste management facilities or sites.

Consider the nature of the waste or material being managed. In some cases, long-term storage may be required.

Recommended Tools:

Interim – Planning Guidance for the Handling of Solid Waste Contaminated with a Category A Infectious Substance

<https://www.phmsa.dot.gov/transporting-infectious-substances/interim-planning-guidance-handling-category-solid-waste>

Carcass Disposal Decision Tree

https://www.aphis.usda.gov/aphis/ourfocus/emergencyresponse/sa_tools_and_training/ct_aphis_disposal_tree

<p>VI. Waste Management Facilities</p> <ol style="list-style-type: none">1. Anticipated types of waste management facilities needed <i>Identify all facility types needed to manage anticipated waste streams and quantities</i>2. Specific facilities identified <i>Provide detailed information on each potential site to aid in selection at time of the incident, including some or all of the following: facility name, type, contact information for site manager and support staff, location information (including latitude/longitude), permit status and compliance history, types of waste accepted, pre-negotiated contracts if any, waste capacity, waste acceptance criteria, financial status, distance from anticipated waste generation points, costs, community concerns</i>	<p>This section should be updated as needed during an incident with facilities that are used or may be used to manage waste during the incident.</p> <p>Communicating with facilities before an incident occurs can help to determine the facilities' waste acceptance criteria, which may be more stringent than what is legally required (e.g., in order to help determine sampling and analysis needs, size requirements).</p> <p>Identify multiple waste management facilities to choose from in case an incident occurs. Waste from wide area incidents may exceed the capacity of local facilities, or facilities may refuse to accept the waste. Out-of-state facilities may be necessary, in which case state permission may be required and different regulations and requirements may apply.</p> <p>In the event that existing waste management facilities do not have the capacity or capability to manage all generated wastes, including those in other communities that are accessible by rail, barge, or truck, planners should consider storing waste long-term, reopening a closed facility, or constructing a new facility. Consider pre-identifying sites for potential new facilities or developing criteria for siting new facilities.</p> <p>Proximity to transportation is an important consideration when selecting a waste management facility, as well as proximity to waste management sites (e.g., whether heavy equipment can access the site to load the large quantities of waste onto barges or railcars for transport to facilities).</p> <p>Recommended Tools: Report on the 2011 Workshop on Chemical-Biological-Radiological Disposal in Landfills https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=239188</p>
<p>VII. Transportation</p> <ol style="list-style-type: none">1. Logistical options2. Routes (including maps)3. Hauler information <i>Provide detailed information on each potential hauler to aid in selection at time of the incident, including some or all</i>	<p>Consult with transportation officials on alternate routes, damaged infrastructure, and other matters impacting transport of waste.</p> <p>Prior to transportation, hazardous material must be classified according to the risks it presents and packaged, marked, labeled, and described on a shipping paper, as required by the Pipeline and Hazardous Materials Safety</p>

of the following: hauler's name, type, contact information, wastes they are permitted to handle, community concerns, security and legal requirements, decontamination needs, insurance requirements, PPE requirements, any special documentation requirements, spill response plan, and pre-negotiated contracts, if applicable

Administration's (PHMSA) Hazardous Materials Regulations (HMR; 49 CFR parts 171-180). Guidance is available on PHMSA's website (<https://www.phmsa.dot.gov>) and through its Hazardous Materials Information Center (1-800-467-4922).

Consider all modes of transportation, including aircraft, vessel and rail, as well as possible differences in restrictions for interstate highways and local roads. Keep in mind packaging, labeling, permitting, security (e.g., for certain waste streams, escorts and computerized, real-time tracking systems may be required), and other transportation requirements (e.g., DOT, state).

Consider the impact of various waste treatment technologies on transportation requirements.

Zoning restrictions may be an issue, particularly for large vehicles.

State permission may be required, which may include obtaining a permit. Expedited permit procedures may be appropriate.

Highway weight restrictions may vary based on time of year.

Consider including a pre-scripted outline or fact sheet of hauler responsibilities, including health and safety requirements.

Drivers may be considered emergency workers and subject to applicable exposure limits.

Drivers and personnel who prepare hazardous materials for transportation may be considered hazmat employees and be subject to training requirements.

Recommended Tools:

PHMSA's website <https://www.phmsa.dot.gov/hazmat>

The Emergency Response Guidebook
<https://www.phmsa.dot.gov/hazmat/outreach-training/erg>

PHMSA Hazardous Materials Information Center
1-800-HMR-4922 (1-800-467-4922); 202-366-4488

	<p>phmsa.hm-infocenter@dot.gov; https://www.phmsa.dot.gov/hazmat/standards-rulemaking/hmic</p> <p>Guidance on Transporting Infectious Substances https://www.phmsa.dot.gov/transporting-infectious-substances/transporting-infectious-substances-overview</p> <p>Guidance on Hazmat Transportation Training Requirements https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/Hazmat_Transportation_Training_Requirements.pdf</p>
<p>VIII. Waste and Material Tracking and Reporting System</p> <ol style="list-style-type: none"> 1. General principles 2. Databases or other tracking software to be used 3. Waste tracking report templates <i>Indicate information to be tracked</i> 	<p>Tracking the waste from cradle to grave helps increase transparency and aids in allaying community concerns. Keep in mind security concerns regarding sensitive information.</p> <p>Use of portable measurement and digital tracking devices should be considered.</p> <p>Haulers, states, and receiving facilities may use different surveying equipment and units of measurement, which should be adjusted as needed to maintain consistency.</p>
<p>IX. Community Communications/Outreach Plan</p> <ol style="list-style-type: none"> 1. Contact information for key stakeholder groups <i>(e.g., community groups, media, government officials)</i> 2. Pre-scripted information for waste management activities involving the public <i>(e.g., fact sheets, public service announcements (PSAs), frequently asked questions (FAQs))</i> 3. Information to aid in establishing a response website once an incident occurs and/or contribute to an incident response website created by the Incident Command or other entity <i>(e.g., hosting information, format, potential contents)</i> 	<p>Past incidents show that communities express more concern with wastes from homeland security incidents than they do with wastes not tied to such incidents (perceived risk vs. actual risk). Community concerns have driven waste management decisions in the past.</p> <p>Community outreach may include detailing special training, required PPE, and safety information, especially during a chemical, biological, or radiological incident, for facility personnel, people who choose not to evacuate their homes and, thus, are living with contamination in their homes, and responders, including volunteers who are helping to clean up the waste.</p> <p>During an actual incident, public outreach takes place within the Incident Command System. Also consider the use of social media and the need for interpreters/translators.</p>

<p>X. Health and Safety for Waste Management Activities</p>	<p>While a general health and safety plan for the incident will be developed, specific waste management activities may require additional guidance and should be addressed. Waste handling at all stages may require environmental monitoring and additional measures to detect and prevent releases to the environment, which may result in harmful exposures to workers or the public (e.g., exposure to fibers from friable asbestos, aerosolization of microbes).</p> <p>Ensure that the overall incident health and safety plan includes information related to waste management activities.</p>
<p>XI. Resource Summary <i>Gathered from all previous sections</i></p> <ol style="list-style-type: none"> 1. Resource needs <i>(e.g., equipment, staff, packaging materials, PPE)</i> 2. Resource sources <ol style="list-style-type: none"> a. Mutual Aid Agreements b. Pre-negotiated contracts c. Specialized experts 3. Specialized technical assistance contacts 4. Contracting <ol style="list-style-type: none"> a. Emergency procurement procedures b. Contract oversight plan 5. Cost accounting/financial management 6. FEMA eligibility guidance 	<p>Resources may be available in-house, from contracts, or through agreements. For any contracting need, possible contractors should be identified and prequalified.</p> <p>Consider that the availability of resources may be impacted by the incident itself (e.g., contamination, physical damage), lack of access (e.g., road damage), adverse weather conditions, competing needs from other jurisdictions or responses, etc.</p> <p>Recommended Tools: FEMA’s Public Assistance Program and Policy Guide https://www.fema.gov/media-library/assets/documents/111781</p>
<p>XII. Oversight Activities and Exit Strategy <i>Describe the process for transitioning each waste management activity back to its pre-incident state, including the scale-down/close-out of each waste management response activity (e.g., waste collection and staging, air monitoring of staging areas) and each waste management oversight activity performed (e.g., site visits/inspections of waste management facilities and sites,</i></p>	<p>This section should be developed and added at the time of an incident.</p> <p>It is important to note that there may be some waste management activities that extend beyond the end of the response that should be addressed in the exit strategy (e.g., long-term monitoring).</p>

sampling and analysis of waste streams), the transition of roles and responsibilities, and the frequency of each activity

RECOMMENDED APPENDICES

- Job Aids for waste management staff positions
 - List of training classes available for different waste management roles
 - Pre-written waste management emergency ordinances, orders, directives, declarations, designations, permits, etc.
 - Maps of waste management facilities and sites, transportation routes, critical waste management infrastructure, and key resources
 - Links to health and safety information
 - Protective Action Guides (<https://www.epa.gov/radiation/protective-action-guides-pags>)
 - Glossary and list of acronyms
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Appendix C:

Hazardous Waste Bulking Center Overview and Public Information Flyers Used for Debris Management During Hurricane Katrina Cleanup in Louisiana

Orleans Household Hazardous Waste and Hazardous Waste Bulking Center Overview

Updated May 13, 2006 by EPA Region 6

Orleans Household Hazardous Waste and Hazardous Waste Bulking Center (10200 Old Gentry Rd, New Orleans, LA 70127)

The Bulking Center receives household hazardous wastes (HHW) and hazardous waste (HW) from EPA and US Army Corps of Engineers (USACE) crews. All HHW are shipped off site as non-hazardous after being categorized according to hazard class. The other waste streams handled include commercial and industrial waste streams or products. These are characterized and bulked if possible prior to shipment as hazardous waste. Water/fuel mixtures recovered from automobile gas tanks are bulked.

Introduction to the Pad

The Orleans HHW/HW Bulking Center (the Pad) is laid out to direct vehicles through a counter clockwise route. This allows EPA crews to drop off commercial/industrial waste prior to entering the HHW area. Also for EPA crews collecting ammunition they must drop this material off before moving on to other locations on the Bulking Center. Although the USACE contractors follow the same route, they proceed to the HHW counting station and then are off-loaded in a sorting area, divided according to waste classification categories.

This summary presents a brief description of the stages of unloading and characterization and what to look for at each station.

Site Safety and Evacuation

Three short blasts on the air horn indicate the need to evacuate the area. Immediately stop what you are doing, observe the wind socks and proceed upwind or crosswind to either the front (adjacent to the office trailers) or back (open field off the southeast corner of the) muster location. If you are driving in the beyond the pad entry area and the evacuation alarm sounds, stop and put the vehicle in park, turn it off, and leave the key in the ignition – proceed on foot to the muster location. One long blast on the air horn means “all clear.”

During severe weather alerts the crews will be instructed to move to the concrete building at the rear of the pad near the propane tank storage area. There are doors on the north and south sides of the building.

Air Monitoring

The Superfund Technical Assessment & Response Team (START) contractors maintain and monitor the air monitors which are generally located in the following locations:

1. Oxidizer Section
2. HHW Hazcat Section
3. Flammable/Bulking area
4. Chemical Offloading Pad (2 monitors)
5. Gas Tank Bulking Area/Haz Cat (2 monitors)
6. Special Refrigerator Storage Area
7. HW storage Pad
8. Cylinder Storage Pad



When the Pad is operating with a limited crew, such as on Sunday when no bulking or Hazcat operations are performed, or when a location has no stored wastes, fewer monitors are needed.

The air monitors measure LEL (Lower Explosive Limit), O₂, CO, H₂S, and VOCs. The monitor at the Special Refrigerator Storage Area monitors SO₂ in place of CO. The monitors in the Oxidizer Section and the Hazcat Section also monitor for CL₂ in place of H₂S. The monitors in the Oxidizer Section, Hazcat Section, Gas Tank Bulking Area/HW Hazcat Area and Special Refrigerator Storage Area also have Gas Alert single gas monitors for Ammonia.

All of these monitors are checked every hour, and the current and maximum readings for each parameter are recorded in a logbook. The units are also data loggers and are downloaded at the end of each day.

START contractors will enter the site in the morning and set up the air monitoring stations prior to entry by the crews. START is responsible for completing air monitoring activities. The ERRS crews at a station are aware of the monitors and have been instructed to move away from the area if the alarm on a monitoring location continues to sound. They will notify START of the alarm. Once conditions have improved the crew can continue working in the area.

1. Site Entry

The administrative trailers are at the site entrance. There is a Command Post (EPA/START) trailer and a contractor (Emergency Rapid Responders or ERRS) trailer. All visitors are requested to sign in and out inside the Command Post. This includes the USACE QA staff and contractors working for the ER Group who are not



assigned to the Bulking Center who come on site to drop off firearms and ammunition. This does not include collection crews only dropping off their HHW/HW loads.

Also in this area are “conex” shipping containers with water, Tyvek, gloves, and other supplies near the ERRS trailer. The break area tent for the pad workers is also located in this area. Portable toilets are located just south of the break tent. The large abandoned building on the site is not to be used by the crews.

There is a stop sign at the truck entrance. Beyond this point hard hat, safety glasses and high visibility vest are required. Cell phones and radios should be turned off. Bobcats, large trucks, and other heavy equipment traverse the pad in various directions past this point, so caution is needed.



There two USACE contractors who monitor their trucks coming and going at this point. These contractors are not under our control so we ask that they sign in and out every day to ensure their safety on the site. The USACE contractors check the HHW trucks come in, looking for hazard items which should not have been collected (e.g., biomedical wastes, ammunition) and for mixed incompatible chemicals; feedback is given to the crews to improve the process. The EPA representative should spot-check this QA process and assist in speeding this check during periodic truck backups. Field Observers might also watch here for unstable or unsafe loads coming in to the PAD. This includes leaking containers that are not bagged and liquids spilled inside the bins.

The HHW/HW pad receives items from multiple contractors working for the USACE and EPA. Currently, we are receiving items from Orleans Parish on a daily basis. Items are also received from Jefferson Parish, although this does not appear to be a regular drop-off. EPA crews are also traveling to Plaquemines Parish a few days a week to pickup HHW from the USACE contractors in that Parish at a central location. The USACE contractors delivering items to the HHW collection site include: EE&G, ECC and CERIS (Jefferson Parish). ECC delivers HHW in two trucks; one is a large stake bed truck and the other is a pickup and trailer marked with ES&H.

Field Observer might watch for PPE being donned prior to entry. Safety glasses, hard hats and highly visible vest are required. Gloves should be worn when any waste materials are being handled. There are hand washing/emergency eye washing stations just adjacent to the corrosives

station, at the Hazcat station, at the drum storage facility, at the battery pad, and within the gas tank bulking facility. Additional PPE is required for workers in the HHW Bulking, Fire Extinguisher Station and Gas Tank Bulking Area.

The drivers of the USACE trucks are not allowed to exit their vehicles while in the pad area, except in an emergency.

2. Counting station.

Only HHW loads are counted at this location. For EPA commercial/industrial waste operations, START contractors are responsible for counting the items, which usually involves drums, cylinders and automobile gas tanks. On the way, the trucks pass the following features that will be discussed further along: scrap metal salvage pad, conex boxes for ammunition and weapons, hazardous waste bulking and storage areas, non-freon refrigerant area, and the pad for standard propane cylinders and commercial-size gas cylinders.

The counting station is staffed by one to two START contractors, according to the day and time. The task of the counters is to count and mark each item (HHW) in the incoming truck. Items are counted in three categories; propane tanks, cylinders, and “smalls”. The “smalls” are essentially anything that doesn’t fall into one of the other categories. Each item is marked with orange spray paint during the count.



We do not count empty containers. Our count is for the tracking of the total quantity of material kept out of the municipal landfill. This allows the Pad to keep a tally of items delivered by EPA and USACE contractors. There are two exceptions to counting the loads: one of the larger ECC trucks is counted when it is unloaded due to the size of the load and the way the bins are stacked; and the box trucks, carrying large items, will be unloaded prior to counting. The counters should never count items inside of box trucks because of the potential for fumes to collect inside the trucks.



The START contractors try to get a true item count although some items such as medicines and other small items that would normally be packaged together are estimated or counted as one item. In addition to not counting empty containers, the counters should not count non-HHW items, such as caulking tubes, hair care products, laundry detergents, incandescent light bulbs and numerous other items, that the crews have been clearly instructed not to collect.

3. Chemical Offloading Pad

Trucks go directly from the counting station to the Chemical Offloading Pad. From this area, all chemicals are taken to the various stations around the pad. Typically the workers from each station gather the materials appropriate to their station in order to have the trucks unloaded more quickly. The stations are described later in this document. From the unloading station the trucks leave the Pad for further collections.

Field Observers should look for items placed in the wrong area, such as waste oils placed on paint pallets, cylinders placed in the wrong holding area (oxygen with flammables) and miscellaneous leaking containers placed in with the leaking paint boxes.

For all areas at the end of the shift the workers should cover with plastic sheeting any items that were not processed and close the lids on any drums or boxes.

4. Household Hazardous Waste and Commercial/Industrial Waste Stations

This is a summary of HHW/HW stations on the Pad, and the procedures at each station. Stations are discussed in counterclockwise order following the route of the truck.

a) Shipping Pad

Bulked waste drums, overpack drums, and waste in Gaylord boxes are stored on a center-draining concrete pad which has a sealed drain. These containers are taken to Phillips Services in Houston, TX. Field Observers should check the condition of the containers and verify that commercial/industrial waste is being handled properly.



b) Fire Extinguisher Station

Here fire extinguishers are emptied, some of them are crushed others are placed directly into a scrap metal roll off bin.

Caution: Some halon extinguishers are designed for high release rates, presenting a high danger; crew members at this station should be reminded to never attempt to discharge them. These units do not have hand-



held triggers. All halon units are now stored in a Gaylord box for delivery to a facility where they can be safely exhausted.

Fire extinguishers are unloaded at the Chemical Offloading Pad and placed in pallets with plywood sides. They are then taken by forklift to the Fire Extinguisher Pad for processing. The powder is placed in a Gaylord box (cardboard 1-cubic-yard box). The powder is taken to Phillips Services in Houston, TX.

c) Scrap Salvage Station

The scrap salvage “crushing” station is located on the west side of the scrap metal roll-off bin. Empty metal containers such as gasoline tanks, fire extinguishers, insulation cylinders, and drums are crushed and placed in the scrap bin. The scrap metal is taken to Southern Scrap. Plastic tanks and drums are also crushed here before placement in the trash roll off bin.



Field observers should watch that the area is roped off during the time the crew is crushing empty containers and that containers are empty.

d) Ammunition and Weapons Storage

Ammunition and weapons are stored but not processed here. Field Observers should make sure the boxes are locked and have “Flammable” placards. The area should be kept picked up, no open containers and no trash in the area. The boxes are moved in and out as needed for disposal. These items are brought in by the Emergency Response Branch teams. The ammunition is taken by Clean Harbors.



e) Battery Storage Area

Batteries are placed on pallets in the HHW unloading pad and full pallets are transferred to the storage pad which is located on the west edge of the site. The batteries are periodically picked up by Interstate Battery Company.



f) Gas Tank Bulking and Commercial/Industrial Waste Storage/Hazcat Operations

Automotive gasoline/diesel tanks are unloaded into the building or on the concrete pad located on the north end of the building. Empty tanks are unloaded directly in the scrap salvage area. The fuel is bulked into drums which are transferred to the drum shipping pad. The empty tanks are then crushed and placed in the scrap metal roll-off. Oil can also be bulked in this area. The observer should make sure that tanks with fuel have all but one of their lines duct-taped in order to prevent spillage or vapor buildup. Hazardous waste (HW) Hazcat testing is also performed in the building.



The HW storage area is located across the road (west) from the gasoline bulking area. Drums are stored here until they are categorized. After Hazcat testing, they are transferred to the drum storage/shipping pad for shipping. The observer should watch for leaking drums and tears in the liners. Drums placed here should have a tracking (“T”) number marked on them; START also marks these drums with a “D” number for tracking purposes.

g) Special Refrigerator Storage Area

Special refrigerators use non-freon refrigerants. Two common refrigerants are sulfur dioxide and ammonia. Like ammunition and firearms, special refrigerators are not processed here. They are only stored until a full load is accumulated; then they will be shipped off site for disposal. Special units include: Sulfur dioxide, ammonia, methyl formate, R-113, and R-23. Based upon information in the NIOSH guide, SO₂ units should be segregated from the ammonia units. Units should be stored in an orderly manner. Units are only accepted from one of our crews. Dumas (an ERRS subcontractor) periodically picks up these units.



h) Tank/Cylinder Pad

Pressure tanks and cylinders (e.g., propane, Freon, oxygen, acetylene) are accumulated here. Propane tanks are off-loaded at the Chemical Offloading Pad and then taken by wagon to the Tank/Cylinder Pad where they are



accumulated prior to being placed on pallets, secured with plastic wrap, and made ready for shipment. These cylinders pallets are stored just east of the pad and are picked up by Blue Rhino.

Containers of Freon gas are handled by the same contractor, Dumas, who does the extractions at the White Goods area. The empty containers are then returned to the site and crushed. The Freon contractor cannot take cylinders without a label. These should be separated for alternative disposal.

Miscellaneous small tanks (insulation, pesticides, and adhesives) are also stored at this location prior to disposal.

Commercial-size cylinders are stored into segregated areas, grouped as flammables, non-flammables, oxidizers and unknowns. Commercial cylinders should have T-numbers marked on them by the collection crews prior to being dropped off at the pad. START will add a C-number at the pad. These numbers are used to track the items into and out from the Pad Site. If the cylinders have owner labels, owners are contacted and asked to retrieve their property. Orphan oxygen and carbon dioxide cylinders will be vented on site; orphan propane cylinders are burned off in the northwest area of the site using large gas cooking burners with pots of water.

Field observers should observe whether the tanks/cylinders are being handled and segregated in a safe manner. Aisle space should be left between the propane pallets to allow access to the containers.

i) Bulking Pad

Oil, antifreeze, poisons, and flammable liquids are bulked here. Most poisons to be bulked arrive in unmarked sprayers (the manual pump insecticide sprayers). The containers first go through the Hazcat station to make sure their contents are compatible. Flammable liquids to be bulked include various oils and gasoline that arrives in gas cans. The flammable liquid drums are grounded to prevent sparking.

Potential issues for a Field Observer to keep in mind here is the potential for some incompatible material to be mixed in with the gasoline and other flammable materials. Gasoline tanks are assumed to contain gasoline, but other uses are possible. Proper grounding of bulking tanks is important to avoid buildup of static electricity. In addition to the protective clothing worn by all pad workers, this area requires respirators and splash aprons. In addition, workers should attempt to bulk and secure all material received at this pad prior to leaving for the night.



j) Hazardous Waste Categorization (Hazcat)

This section is where unknown materials are separated into broad categories according to their hazard class (as opposed to specific chemical make-up). The Hazcat station workers may wear Level C PPE during some categorization.



The purpose of the hazard categorization (Hazcat) and segregation is to pack and bulk items for shipping and prevent incompatible chemicals from being packed and shipped together. Incompatible chemicals might react with each other during shipment and cause fire, toxic vapors, explosions, or other dangerous reactions.

Actual identification of each and every chemical is not required in order to pack products for shipping, and, given the large number of items passing through this facility, such identification is not practical.

With minor modifications specific to this site, personnel at the Hazcat station at this pad follows procedures outlined in the Environmental Quality Management, Inc., Standard Operating Procedure.

Because this analysis is conducted outdoors, fume hoods are not required.

1. Sample Documentation: Record color, clarity, and other physical description of the sample.
2. Air Monitoring: Screen the sample with a PID (Photo Ionization Detector) or FID (Flame Ionization Detector) to help identify volatile compounds in the sample.
3. Solubility Testing: Water will be used for solubility testing at this site.
4. Density Test: Used for insoluble compounds. Recorded as lighter or denser than water.
5. Sample Reactivity: Air reactivity is observed upon opening the sample prior to hazcat testing. Air reactivity is normally a result of a reaction with moisture in the air.
6. Water Reactivity is noted during water solubility testing.
7. pH Test: pH is tested during water solubility testing. The pH strip is first immersed in water to wet it. The strip is then placed in the sample. The strip color is compared against a chart.
8. Peroxide Test: Flammable solvents should be tested for the presence of peroxides. Peroxide strips are used for this test. The strips should be quality control checked daily by immersing them in hydrogen peroxide.

9. Oxidizer Test: This test also uses a test strip. The strip is wetted and one drop of 5% HCl is added to the strip. If oxidizers are present, the strip will turn a blue-black color. These strips should be quality control checked daily.
10. Cyanide Test: The cyanide test is available here, but is not normally run because cyanide is not a common household chemical.
11. Sulfide Test: Add sample to the test kit tube, add a few drops of HCl. After agitation the lead acetate paper will turn blue-black if sulfides are present.
12. The Bielskien Test: This test is used to determine if solvents are chlorinated solvents. The test will not be run at this site.
13. Flash Point: A small portion of the sample is added to a watch glass. A lighted match is then held near the sample. If it lights, it is definitely flammable. If the match has to touch the sample to light it, flash point is approximately 140° F. If it takes longer than a second to light the sample the flashpoint is over 140° F.

k) Oxidizer Area

This area is at the south end of the bulking/sorting tables located behind the unloading area. This area receives oxidizers including bleach, certain pool chemicals, and peroxides. These chemicals give off oxygen and can cause or enhance the combustion of other materials. Chemical names ending in “ate” or “ite” such as chromate or nitrite, or beginning with “per” or “peroxy” indicate oxidizers.

Note that older pool treatment chemicals might be hypochlorite, an oxidizer, while newer pool chemicals may be organic chlorinators such as isocyanurates (cyanuric acids), which are incompatible with hypochlorites, strong bases, and strong acids!! This is an example of products that might be purchased for the same purpose, but are not compatible.



l) “Household” Section

This is not a DOT category, but this section sorts chemicals from a wide variety of household products into the appropriate containers. Acids and alkalines are packed separately. Many products fall into a broad category called “paint-related materials” or PRM. These are boxed as non-hazardous (for example, latex paint or caulking) if they don’t contain hazardous chemicals, or drummed as flammable if oil-based or containing flammable liquids like alcohols.

Sometimes seemingly-related materials need to be put in separate categories. For example, automobile windshield fluid is a flammable PRM because it contains methanol, while Windex is an alkaline because it contains ammonia. Another example is toilet bowl cleaner, which may be either a strong acid or a strong base. All HHW is shipped to Phillips Services in Houston, TX.



m) Poisons

The term “poison,” according to the DOT classification, simply means that it has been classified as toxic even in small doses. Products may contain the word “poison” in the warning label as a warning against ingestion, but not necessarily fall under the DOT classification. Common vaporous products found in this section are insecticide gasses, solvents, isocyanates, refrigerants, and chlorinated materials under pressure. These items should either be capped, or have their spray nozzle heads removed prior to packing.



Poisons in solid form may include medicines (frequently in prescription pharmacy containers), pesticides & herbicides (like powders or granules in bags). Reactive chemicals such as corrosives and oxidizers should be kept separate from these materials.

Various drums and lined Gaylord boxes are located behind these tables for the various categories of waste.



n) Flammable Section and Paints

This section separates flammable solids, liquids, and aerosol cans into appropriate containers. Flammable liquids should be packed in drums if leaking.

Paints are palletized according to latex or oil, and transported to the front of double-lined roll-off containers (one for oil, one for latex). Oil paint cans are transported to a facility to be crushed, and the paint used to make a fuel. Latex is dried and disposed. Cans are recycled.



o) Batteries

Automotive Batteries are palletized. They are wrapped in yellow chemical resistant absorbents if open or leaking. Full pallets are stored on the west edge of the facility for pickup.

Small Batteries are separated and drummed depending on the type.



p) First Aid and Emergency Showers

The first aid station is located on the left side as you enter the HHW/HW operations, just outside the exclusion zone. One emergency shower and eye wash station is located next to the first aid station. The other one is located in the drum storage building. Other emergency eye wash stations are located near the Corrosives (battery), Hazcat, Oxidizers, and Gas Tank Bulking stations. One first aid responder is on site at all times of operation.

HURRICANE RESPONSE



St. Tammany Parish

HOUSEHOLD HAZARDOUS WASTE DROP-OFF

Final Dates for Drop-off at EPA Sites - Now through DECEMBER 20

- **CLEANERS** (such as bleach and ammonia)
- **ROACH & OTHER PEST KILLERS**
- **PAINT & WORKSHOP SUPPLIES**
- **AUTOMOTIVE PRODUCTS**
- **FLAMMABLE PRODUCTS** (such as oil, gas and propane)
- **LAWN & GARDEN PRODUCTS**
- **OTHER HOUSEHOLD CHEMICALS**
- **FLUORESCENT LIGHTS**
- **THERMOMETERS**
- **BATTERIES**
- *Televisions, computers and other electronics will also be collected.*

DROP-OFF LOCATIONS AND SCHEDULE:

Western St. Tammany Parish

Open 8 am to 4 pm Monday through Friday (last day for drop-off December 20)

Mandeville High School – To access the site, take the West Causeway Approach to Mandeville High Boulevard. Take Mandeville High Boulevard to the circle at the end of the road – look for yellow signs.

Northern St. Tammany Parish

Open 8 am to 4 pm Saturday, Sunday and Wednesday (last day for drop-off December 18)

Near Parish Jail in Covington – To access the site, take Columbia St. to Champagne St. and follow signage.

Eastern St. Tammany Parish

Open 8 am to 4 pm seven days a week (last day for drop off December 20)

Near Slidell, eastern gate of Camp Villere – To access the site, take US Hwy 11 to Browns Village Road just north of I-12. Drive about two miles west following signs until you reach the end of paved road at the East Gate of Camp Villere. Drop-off site is just inside the gate on the left.

At household hazardous waste collection centers, we CANNOT accept: commercial or industrial waste, medical waste, building materials, vegetation, debris, and large appliances.

For more information on household hazardous waste disposal, call EPA at **1-800-401-1327** (prior to December 20) or the St. Tammany Parish Environmental Service at 985-898-5243 (after December 20). For questions on ammunition, guns or explosives, call 817-233-2757.

* Large appliances (white goods) should be placed curbside. Do not take them to drop off locations.

Flyer prepared on December 13, 2005 – F50

HURRICANE RESPONSE



St. Tammany Parish

LARGE APPLIANCES (WHITE GOODS) FREE CURBSIDE PICK-UP

Items Must be Curbside by JANUARY 2, 2006

- AIR CONDITIONERS
 - REFRIGERATORS and FREEZERS
 - STOVES AND OVENS
 - MICROWAVE OVENS
 - DISHWASHERS
 - WASHERS AND DRYERS
 - WATER HEATERS
 - *Televisions, computers and other electronics will also be collected.*
- TO ENSURE A CURBSIDE PICK UP, OR FOR FURTHER INFORMATION ON COLLECTION, CALL THE EPA HOTLINE AT 1-800-401-1327.
- You MUST place all items at the side of the road (Collectors CANNOT pick up white goods on private property). Do not place items in a ditch or on the road.
- Items must be curbside by **January 2, 2006**. Crews will begin to pick up white goods and electronics on January 3, 2006.
- This will be the final pick up of white goods in St. Tammany Parish by EPA and the Army Corps of Engineers.

Flyer prepared on December 13, 2005 – F49

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Office of Resource Conservation and Recovery

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<http://www.epa.gov/homeland-security-waste>

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