Storm Planning for the Urban Forest

May 2023

MODULE 3

Debris Management Sites

Green Infrastructure Center

GEORGIA FORESTRY COMMISSION

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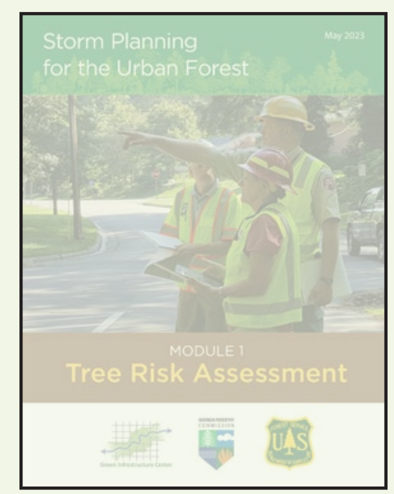
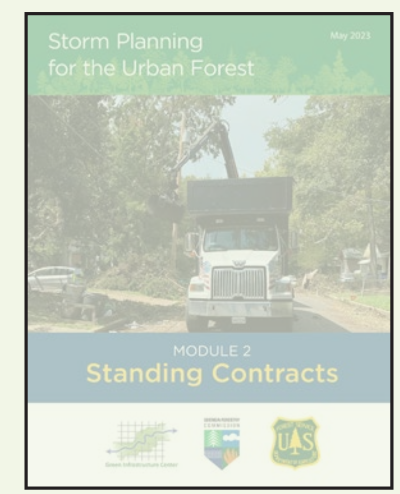
Storm Planning for the Urban Forest

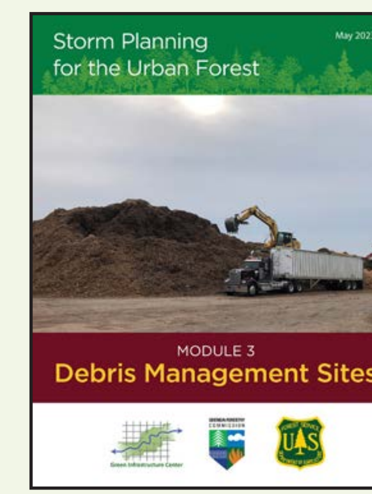
Effective storm planning for the urban forest entails three foundational activities: tree risk assessments, standing contracts, and debris management sites. These are discussed in detail in the following modules:

- **Module 1: Tree Risk Assessment**
- **Module 2: Standing Contracts**
- **Module 3: Debris Management Sites**

Below are the steps for identifying and establishing a debris management site in your community. For further modules on creating a tree risk management program for your urban forest or developing standing contracts for storm cleanup response, see the Community Forestry Academy's website at: https://communityforestry.academy/courses/community-planning-for-the-urban-forest-strike-team/







Module 3: Debris Management Sites

Introduction

Storms and severe weather events – in the Southeastern U.S. are rising in frequency, duration, and intensity, along with an increased occurrence of the strongest storms – those of Category 4 and 5 (Kossin 2007). Tornadoes and other severe thunderstorm phenomena frequently cause as much annual property damage in the U.S. as hurricanes, and often cause more deaths (Mellilo 2014). New research suggests that favorable conditions for these types of storms will also increase under future climate scenarios (Diffenbaugh 2013). These new climate trends raise the importance of emergency preparedness and community disaster plans.

One critical component of emergency planning is the identification of sites to store, manage and process storm debris. The sheer volume of material generated from extreme weather events can overwhelm communities. A prepared community will identify suitable sites in advance, acquire the appropriate permits and set up necessary infrastructure to be ready when the next storm strikes.

Photo credit: Georgia Forestry Commission

Debris can pile up quickly and require a lot of available and cleared land to manage.

Photo credit: Georgia Forestry Commission

Additional space is needed to account for the staging of equipment, monitoring the site, buffers, and roads to allow truck traffic to easily navigate the site.

What are debris management sites?

Debris management sites are properties identified and secured prior to a storm to accommodate the storage and processing of large volumes of woody debris, and sometimes mixed debris, in the aftermath of a major storm event. The official FEMA term is Debris Management Sites (DMS) and such sites should be included on tree risk assessment maps. Following a storm, routes to these debris management areas should be cleared immediately following the clearing of routes to critical facilities.

Debris collection and processing

Debris management sites are typically reserved for major events that generate larger volumes of debris. The amount and types of debris generated depend on the type of event and the mix of land uses and population density in the community. Vegetative debris is bulky and consumes a significant volume of landfill space if buried. To minimize the use of landfill space, vegetative debris volume should be reduced before disposal. Mulching or grinding vegetative debris can reduce its volume by as much as 75 percent, while burning can reduce it by 90 percent. Burning may cause other environmental impacts, so mulching is preferred if there is room to utilize the mulch later on (FEMA 325, Public Assistance Debris Management Guide). While the rates for burning and chipping/grinding are about 200 cy/hr , using on site chipping/mulching necessitates local storage until later disposal/use can be arranged.

In addition to space for storing and processing the volume of material, space is required to layout roads, set up monitoring equipment for facilities to support site workers and other infrastructure such as fencing or buffers to protect adjacent land uses from noise, dust, or smoke. Historic disasters have shown that it takes 100 acres of land to process one million cubic yards of debris (FEMA). The U.S. Army Corp of Engineers (USACE) has found that approximately 60 percent of the debris management site will be used for roads, buffers, burn pits, hazardous household waste (HHW) disposal areas, etc. (FEMA 325, Public Assistance Debris Management Guide).

Traffic circulation also needs to be well defined since emergency workers may be unfamiliar with the site, routes and surrounding area and they need to safely navigate to and from as well as within the site. If street signage has been lost, temporary signs may be needed to direct emergency crews. Debris sites should be able to accommodate traffic entering and exiting from different access points and must be staffed with monitors at each site's access. Monitors will determine which trucks are full or empty of debris and track and document loads as they arrive and depart. To reduce confusion for monitors, separate locations should be used for ingress and egress of trucks hauling away compacted (reduced volume) debris for final disposal versus those trucks that are depositing newly collected debris.

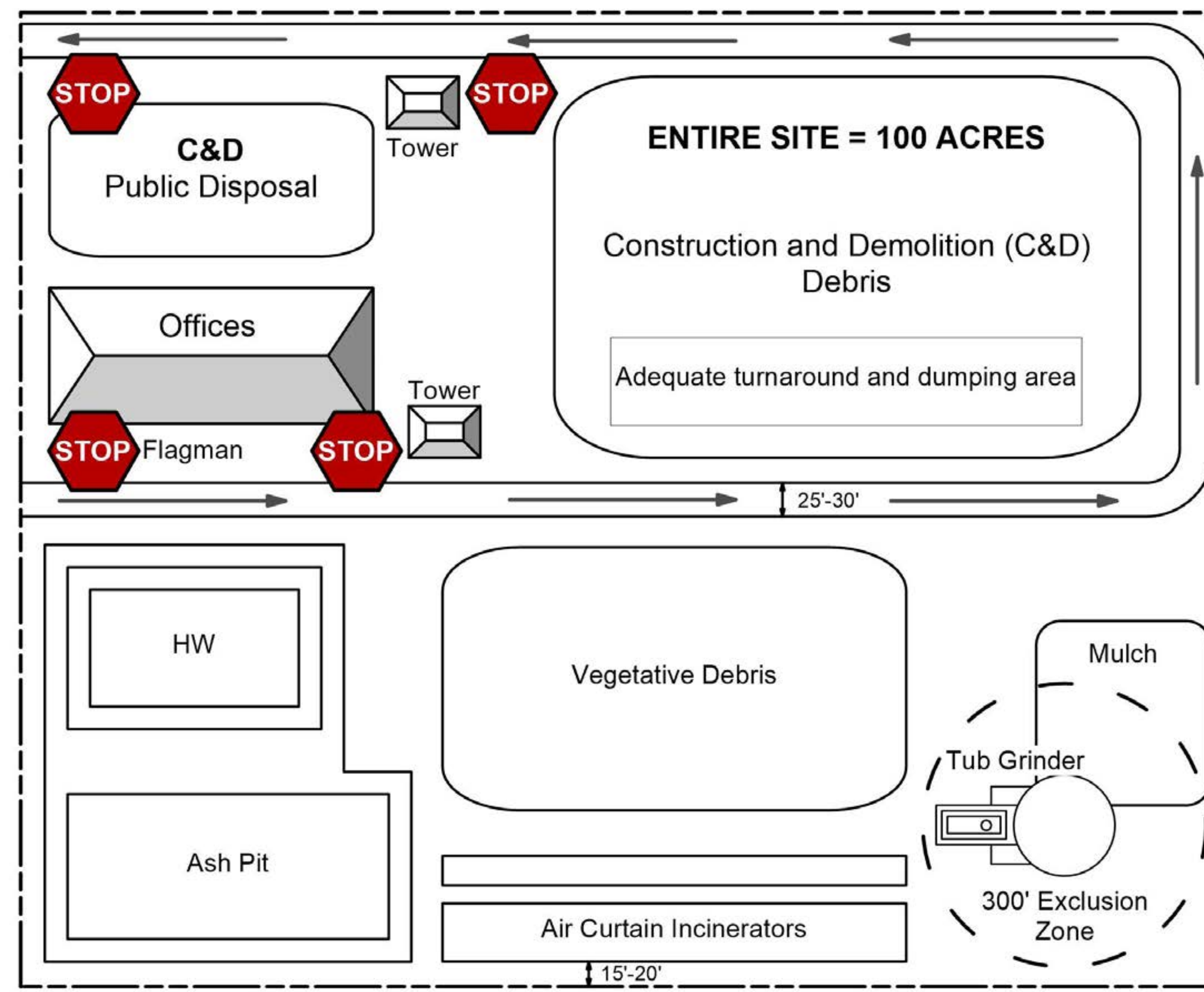


Photo credit: Federal Emergency Management Agency (FEMA)

An example layout of debris management site.

Advantages and Disadvantages of Debris Management Sites (DMS)

from FEMA 325, Public Assistance Debris Management Guide.

Advantages

- Allows flexibility in debris management.
- Debris can be sorted, recycled, and reduced prior to disposal.
- Temporary sites for staging debris provide time to prepare for and stagger final disposal operations.
- Centrally-located sites reduce hauling time for debris and costs for the cleanup effort.

Disadvantages

- Additional costs are incurred from handling the debris twice, once at the DMS and a second time at the disposal site.
- Leasing private land to manage debris is expensive (if no public land is available).
- Requires upfront funding for proper planning, engineering, and permitting of the site.
- Environmental and historic preservation compliance reviews are required.
- Extensive site cleanup may be necessary to close the site, once operations are complete.
- DMS requires dedicated site management and staff.

How big should a debris management site be?

First, figure out how much debris could be generated from a storm.

The Army Corp of Engineers developed a formula (*next column*) to help communities estimate the relative volume of debris to anticipate based on different storm categories and landscape characteristics. The estimated quantities produced by the model have a predicted accuracy of ±30%. Use the worst-case scenario to estimate a storm's debris generation potential to plan appropriately for debris site capacity.

The Model Formula:

$$Q = H \times C \times V \times B \times S$$

where:

Q is the quantity of debris in cubic yards.

H is the number of households.

C is the storm category factor in cubic yards.

V is the vegetation cover multiplier.

B is the commercial/business/industrial use multiplier.

S is the storm precipitation characteristic multiplier.

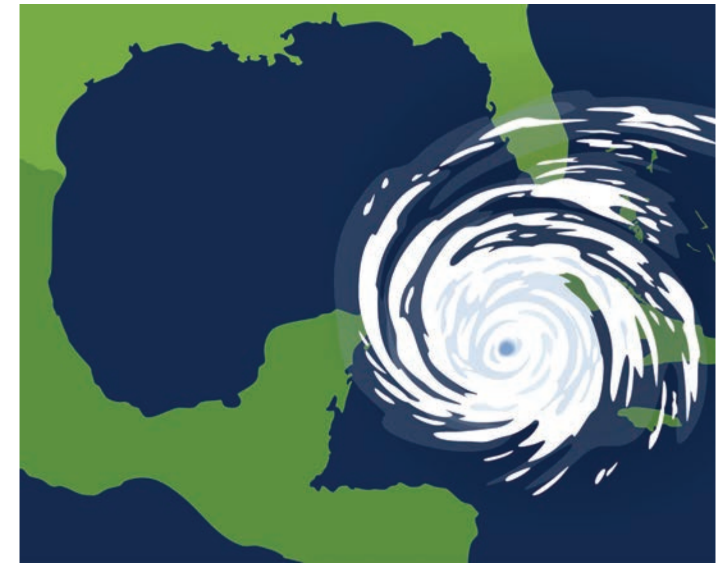
Photo credit: Green Infrastructure Center

Use the most recent U.S. Census data to calculate the number of households (H) in the community.

H Number of Households (H)

To determine the number of households, use the most recent population (P) statistics from the U.S. Census (https://data.census.gov/) for the affected area. The model assumes a standard household of 3 people.

Known/estimated population (P) for a jurisdiction may be used to determine a value for H or H=P/3.



C Storm Category Factor (C)

The strength of the storm is a major determining factor when estimating potential debris volume.

Hurricane Category	Value of (C) Factor
1	2 cubic yards
2	8 cubic yards
3	26 cubic yards
4	50 cubic yards
5	80 cubic yards

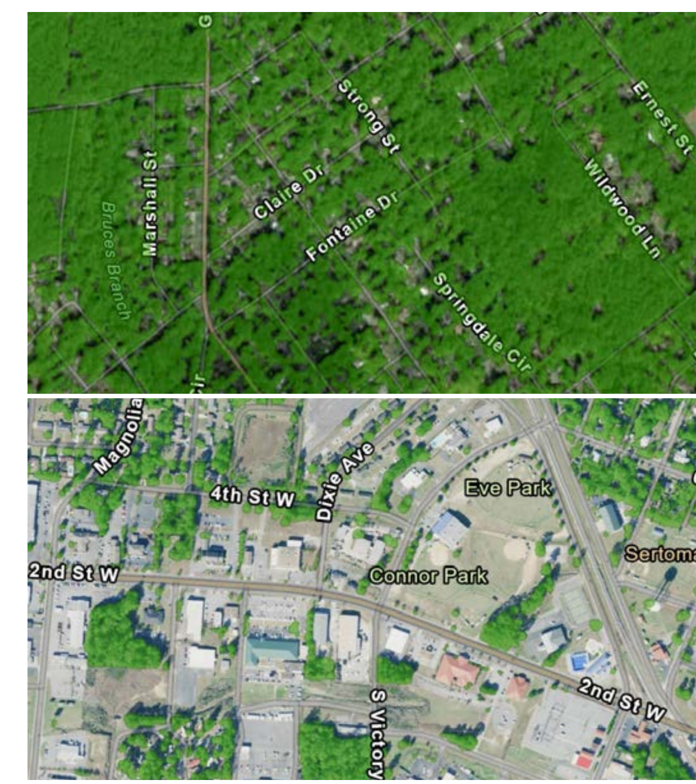
Clean up after Hurricane Michael a 2018 Category 5 storm that brought wind gusts in the 60-75+ mph range to Georgia, downing countless trees and power lines.

V Vegetative Cover Multiplier (V)

This multiplier factors in the vegetation of the community and can range from light to medium to heavy. The following descriptions help classify the correct vegetation multiplier for your community.

- **Light vegetative cover** includes new home developments where more ground is visible than trees. These areas will have sparse canopy cover.
- **Medium vegetative cover** generally has a uniform pattern of open space and tree canopy cover. This is the most common description for vegetative cover.
- **Heavy vegetative cover** is found in mature neighborhoods and woodlots where the ground or houses cannot be seen from above due to the tree canopy cover.

Vegetative Cover	Value of V Multiplier
Light	1.1
Medium	1.3
Heavy	1.5



The image on the top shows an example of a heavy vegetative multiplier versus an example on the bottom of a light vegetative multiplier.

B Commercial/Industrial Multiplier (B)

This multiplier takes into account small retail stores, schools, apartments, shopping centers, and light industrial/manufacturing facilities. The model assumes commercial insurance requirements will offset some cleanup and salvage operations since commercial properties are ineligible for FEMA's Public Assistance Grant, except in cases where there is a clear public benefit. There are no clear standards in FEMA's 325 Public Assistance Debris Management Guide to distinguish between light versus medium versus heavy commercial density. In general, municipalities with significant commercial districts should use the heavy density multiplier while communities with limited commercial districts use medium density and small rural communities or strictly suburban residential commuter areas should use light density.

Commercial Density	Value of B Multiplier
Light	1.0
Medium	1.2
Heavy	1.3

The image on the top shows an example of a heavy commercial density versus the image on the bottom of a light commercial density.

S Storm Precipitation Characteristic Multiplier (S)

The amount of precipitation can significantly increase the volume of debris generated. Very wet storms will cause ground saturation, increasing the likelihood for trees to fall. Use the medium to heavy precipitation characteristic multiplier in the formula to plan for the worst-case scenario unless the region's storms are mostly wind-driven with characteristically light precipitation.

Precipitation Characteristic	Value of S Multiplier
None to Light	1.0
Medium to Heavy	1.3

Photo credit: Green Infrastructure Center

Heavy precipitation saturates the ground and can increase tree fall.

PRO TIP

Be sure to estimate your potential debris volume before inventorying possible sites. Use worst case scenario in your estimates.

Example: Calculating Hypothetical Debris Volume for Albany, Georgia

Imagine a category 4 tropical storm passed through Albany, GA: a city with primarily single-family dwellings with some apartment complexes, schools, shopping centers and industrial areas. The city's residential landscapes with mature trees, scattered parks, and large forested natural areas require use of the high vegetative cover multiplier. The slow-moving storm contained significant moisture resulting in rainfall before the main storm arrived and rainfall continued for several days afterward.

Under this hypothetical scenario, the City of Albany could expect:

Q = H x C x V x B x S

Population (P) of Albany, GA is 69,048*
(P) / 3 = (H) # of households
69,048 / 3 = 23,016

H = 23,016 households
C = 50 cubic yards for a category 4 storm
V = 1.5 for heavy vegetative cover
B = 1.3 for heavy commercial density
S = 1.3 for a medium to heavy precipitation storm

Q = (23,016) x (50) x (1.5) x (1.3) x (1.3)

Q = 2,917,278 cubic yards of debris

*2021 population data.

Use calculated debris volume to estimate necessary site size.

Before calculating the size of the debris site using the volume metric, there are some additional factors to consider for the debris staging site.

Assuming the debris pile stacks will be limited by a height of 10-feet, a single acre can hold about 16,117 cubic yards of woody debris. So, from this Albany example, using a 10-feet high stack, **2,917,278 cubic yards/16,117 cubic yards** = **181 acres to store debris**

Infrastructure Space

The site will also need space to install roads, safety buffers, burn pits and household hazardous waste areas. According to Army Corp of Engineers (USACE) this takes **up 60%** of the usable land area of the site. To provide for roads and buffers, the acreage must be **increased by a factor of 1.66** to accommodate the necessary infrastructure to run a debris staging site.

Therefore,
181 acres x 1.66 = 300 acres total land area needed

Tree Debris Only

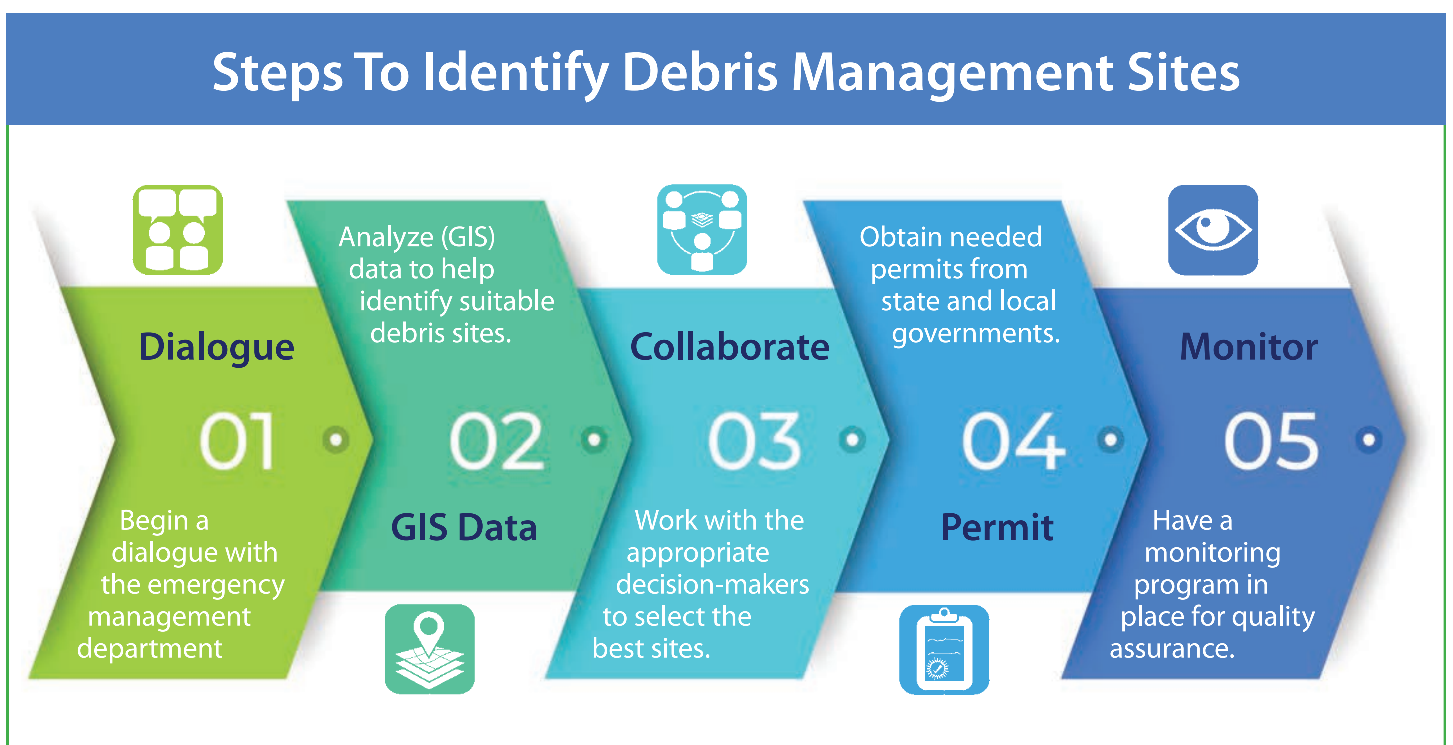
Commonly, hurricane-generated debris consists of 30% clean woody debris and 70% mixed construction and demolition (C&D) debris. When calculating the site size requirements for woody debris only, using this Albany example results in:
300 acres x 30% clean woody debris =
90 acres needed for clean woody debris.

Photo credit: Georgia Forestry Commission

Reducing the volume of debris is a time consuming but critical operation on the debris management site.

Debris Processing Time

Another factor affecting site size requirements is the rate at which a community processes debris. Process times vary with the size of the site, distance from the site to the affected community, reduction (compaction or mulching) time, and urgency to remove debris. The USACE estimates it takes between 45-60 days to process 100 acres of debris. And although clean woody debris processes faster than mixed debris, it still requires sorting and cleaning before reduction and disposal.



Step 1: Begin a Dialogue with the Emergency Management Department

As with **Module 1: Tree Risk Assessment** and **Module 2: Standing Contracts**, starting a dialogue with emergency management personnel early in the process will make it easier to plan for and identify debris management sites. For some communities this process may require cross-jurisdiction coordination. For example, a city may need to coordinate with the county to find an appropriate debris management site. Emergency management staff have experience and can assist with coordinating resources across jurisdictions.

Step 2: GIS Data Analysis

Geographic Information Systems (GIS) data and analysis can help the storm team identify suitable debris management sites. Local parcel data can be analyzed based on several factors such as size, ownership, and proximity to resources to find suitable sites. Small communities may need to expand their parcel analysis to include adjacent jurisdictions. Parcel size, ownership, and proximity can be analyzed as follows:

Size

First, filter parcels by size to find suitable sites. In the example for Albany, GA 300 acres was determined to be necessary for meeting the processing demand for all types of post-disaster storm debris for a chosen storm. Filtering parcels based on a 300-acre minimum will identify sites large enough to accommodate the debris operations. In some cases, several smaller proximate sites may need to be considered if the inventory of larger sites is insufficient.

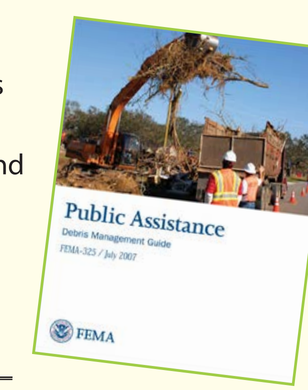
Ownership

Next, filter parcels by public ownership. As noted, use of public sites avoids costly leasing fees and minimizes conflicts. If no suitable public properties are available within the jurisdiction, consider using adjacent local government lands such as county or school district properties as well as state-owned lands that can accommodate the debris management functions and size. In some cases, private property may be the best available option for a debris management site and this will require further investigation and a land lease agreement.

Land Lease Agreements with Private Landowners

A land lease agreement with a private landowner for a Debris Management Site (DMS) should cover the entire duration of the operations beginning with the environmental and historical compliance review and ending when the property owner regains legal use of the property. The agreement should include a baseline environmental evaluation of the site before site occupation and another review before the site is returned to the owner. The agreement should indicate that the lessee will be responsible for any environmental remediation necessary to revert the site to its previous condition (see the section below on Environmental and Historical Preservation Concerns). Land lease agreements should specify a timeframe for debris removal and processing operations while allowing for the ability to extend the agreement if activities are not completed in the initial timeframe.

Review FEMA 325, Public Assistance Debris Management Guide for more information on land lease agreements.



Link: https://www.fema.gov/sites/default/files/2020-07/fema_325_public-assistance-debris-mgmt-plan_Guide_6-1-2007.pdf

Access to major roadways

Parcels should be filtered based on proximity to major roads to find sites that are centrally located. The debris management site (DMS) should be located for easy access to major road infrastructure that can handle heavy truck traffic. Cleanup time is reduced by quickly collecting and delivering debris from rights-of-way (RoW) to the DMS. Routes leading to the DMS should be sensitive to nearby disputing neighborhoods and businesses, while avoiding creation of hazardous or unsafe conditions for residential areas or schools. The DMS also necessitates ingress and egress planning that considers the impact of large trucks on local traffic patterns. Municipal staff may need to adjust traffic signals to accommodate projected truck traffic along critical haul routes. If power is out, staff may need to manually direct truck traffic.

Land cover

Land cover is another key filter to use when selecting appropriate sites. Sites that are already open and cleared are preferred. Large, forested parcels are not suitable for staging debris. Use local land cover data or the National Land Cover Database (NLCD) to locate parcels with significant open space such as pasture lands. Avoid sensitive sites such as areas with wetlands. The National Wetlands Inventory (NWI) can be used to locate wet areas but note that it often misses or misidentifies wet sites.

Utility hookups

Sites will need utility access (electricity, water, etc.) to power lighting, machinery, and equipment, and to support onsite workers monitoring and managing the facilities. Ensure the site has access to local utilities, critical to its operation. Consider whether and how backup generators or temporary power could be sited in case usual power supplies are out or unreliable. FEMA offers assistance through the USACE to provide temporary emergency power needed for debris cleanup.

Learn more at https://www.usace.army.mil/Missions/Emergency-Operations/emergency_support/ There are also private firms that provide such services and can be part of precontracting for disaster response.

PRO TIP

Use GIS to narrow down sites that best meet your criteria for a Debris Management Site.

Proximity to population centers

Parcels should be filtered by proximity to population centers to centrally locate sites. The closer staging sites are to population centers, the easier it will be to get materials out of the RoW to the DMS. However, impacts of noise and disturbance to nearby residents is a consideration. Potential smoke from burning debris, around the clock light and noise, dust, and heavy truck traffic may cause conflict with neighbors. Municipal staff should notify residents about potential uses for the site and expected activities well ahead of a disaster.

Proximity to disposal sites

Proximity to disposal centers or landfills is another important consideration. Site considerations should include distance from the DMS to the final disposal site since travel time is a major cost for material hauling. If not burning the debris then it will need to be reduced on site before hauled to its final landfill or composting facility. The Environmental Protection Agency (EPA) maintains a Disaster Debris Recovery Tool in an online ArcGIS map. It shows landfill locations and recovery centers as well as the types of accepted materials. Use this tool to locate debris management site nearest to final disposal sites.

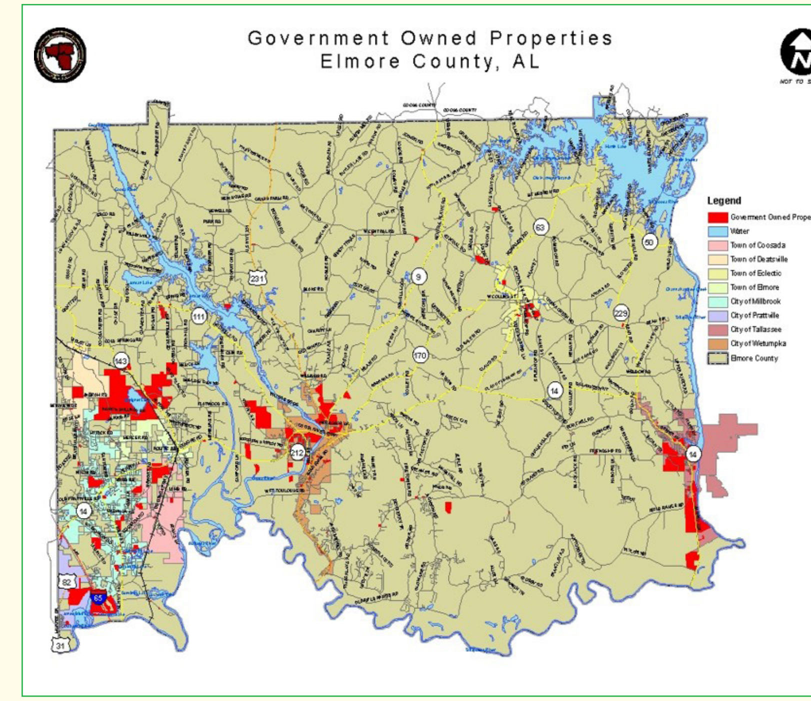
Link: https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=2fec4eed18c140c8aa4bb0a74f207b65

Identify high risk areas

An analysis of risk distribution across the jurisdiction can be used to inform the DMS location. This analysis can be based on tree canopy coverage since heavily canopied residential neighborhoods and population centers will generate more debris than areas with low or no tree cover. This analysis could also use tree risk assessment details and the Urban Tree Risk Index tool (see **Module 1 Tree Risk Assessment** for more details). Areas of highest risk without any mitigation are more likely to generate debris during the storm.

Case Study: Elmore County and the City of Millbrook, Alabama

The Central Alabama Regional Planning and Development Commission (CARPDC) in partnership with the Alabama Emergency Management Agency (AEMA), the Alabama Forestry Commission, the Society of Municipal Arborists (SMA) and the Alabama Association of Regional Commissions (AARC) developed a GIS application for identifying suitable debris management sites in a region. They used Geographic Information System (GIS) data to locate a suitable DMS in Elmore County, Alabama. Applying the site considerations discussed earlier, the planning team identified all of the public properties (red) owned by the government or by school boards. They analyzed which sites were linked to areas with the greatest population density, tree canopy coverage, road access and used the Urban Tree Risk Index (UTRI) by street segment. From this analysis they were able to identify more than 12 viable sites in the county. The planning team ultimately decided on a site located in the City of Millbrook, Alabama. It was owned by the school board and currently vacant, with plans to locate a future school. Favorable site factors included its openness as pasture, large enough for establishing a DMS, and access to a state highway. It also could be easily fenced to prevent unauthorized access or dumping, with adequate space for sorting vegetation and construction debris. Once it was determined as a suitable staging site, the next steps to obtain a future lease could be undertaken.



Step 3: Collaborate and Plan

Convene the appropriate parties and decision-makers to work with GIS data to select the best sites. Although private property can be included, it will require additional investigation and an access contract. Selected sites will need to be inspected on the ground for suitability along with collection of specific baseline data documenting pre-disturbance site conditions.

Photo credit: Georgia Forestry Commission

Collaborate with your storm team and decision-makers on what would be the best sites(s).

Environmental and Historic Preservation Concerns

Debris management site (DMS) selection should consider existing site conditions, site context, and how the site will be restored to these conditions upon site closeout. A DMS should not be established in environmentally or historically sensitive areas such as wetlands, critical habitat, 100-year floodplains, sole source aquifers, freshwater well fields, Superfund sites, historic districts, or archaeological sites. DMS selection should also consider the context of the site and avoid or minimize adverse impacts on minority or low-income populations in accordance with EO 12898.

Baseline data collection will allow for a site analysis to determine its suitability and detect environmental or historic preservation issues. If an environmental or historic preservation issue is found, rank the site lower than other considered sites. If a site with one of these issues will be used as a DMS, then state and local environmental and historic preservation compliance reviews will be required.

Baseline Data Collection

Complete baseline data collection prior to establishing a DMS. Following site selection, a Debris Project Manager (DPM) should work with local, tribal, and state officials to establish baseline data criteria. Document the existing conditions of the land before disturbance so that all private and public land used as a DMS can be returned to its required original condition at the end of debris operations. Baseline data collection should include:

1. **Take Videos and Photographs.** Capture the entire site through videos and photographs both on the ground and aerially before any work has begun. Track the changes on the site with periodic videos and photographs. Photos should have GPS capability to tag them to locations.
2. **Document Existing Conditions.** Make note of locations and conditions of physical features such as structures, fences, culverts, irrigation systems, and landscaping as well as existing damage. Thorough notes will help with evaluating future damage claims.
3. **Investigate Site History.** Research past uses and site ownership. Contact the State Historic Preservation Office (SHPO) for additional site information. Document any significant or historic structures or buildings and any archaeological sites. Use your state or county's brownfield and hazardous sites database to avoid known hazardous areas.
4. **Sample Soil and Water.** Since some contamination may be unknown, collect and test new samples of soil and groundwater prior to site use. Work with the state environmental agency to establish requirements, chain of custody, sampling methods, certified laboratories, and testing parameters or establish a contract with an environmental consulting firm for sampling work. Areas planned for storage of household hazardous waste (HHW), ash, or fuel should be sampled prior to set up and any areas proximate to surface water or highly permeable soils or karst areas should be avoided. Also note the proximity of public wells and avoid wellhead protection areas (consult your state's drinking water agency for their definition of a public well and the avoidance area required).

Step 4: Obtain Site Permits

Obtain all necessary permits from state and local governments before formally establishing the DMS. Examples of permits include environmental permits (air quality, water quality, etc.), burn permits (if burning debris instead of using other reducing methods), land-use permits, and permits for processing hazardous waste or other waste materials. If the area is normally windy, location of burn areas may necessitate consideration of wind patterns and proximity to roads where blowing smoke could impair site lines of motorists.

Photo courtesy of: Georgia Forestry Association

Step 5: Monitor the site.

Environmental Monitoring Program

The DMS should have an environmental monitoring program in place to collect data throughout the operation of the site for quality assurance and to aid in closing out the site after operations have ceased. This monitoring is separate from the debris hauling monitoring mentioned during **Module 2: Standing Contracts**. Environmental site monitoring ensures that the site complies with state and local permits and relevant laws such as the Clean Air and Clean Water Acts and can provide data for site remediation. Typical elements of a monitoring program include:

1. **Map of Site Operations.** DMS operations may shift location and extents over time. Activities such as hazardous waste collection, fuel storage, or equipment storage should be tracked by periodically mapping or sketching their locations. This will allow for areas of concern to be located to test for contaminants in soil and water following the end of debris operations.
2. **Document Quality Assurance Issues**. Document issues that will impact site closeout such as petroleum spills at fueling sites, hydraulic fluid spills at equipment breakdowns, or discovery of household, commercial, agricultural, or industrial hazardous waste.
3. **Restore Site**. Plan the site restoration early in the process and include restoration provisions in the lease. Final restoration must be acceptable to the landowner within reasonable expectations that are agreed to in writing before commencing operations.

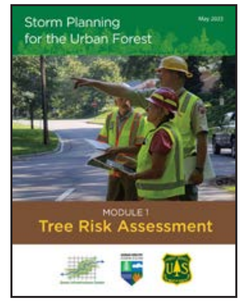
Conclusion

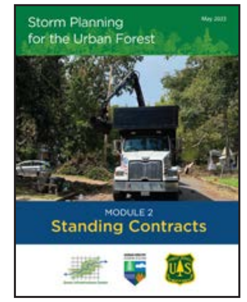
This module outlined the steps to identify and secure debris management sites -- one of the foundational activities for storm planning for the urban forest. All communities should create a Disaster Debris Management Plan as part of a broader Emergency Management Plan.

To learn more about the other two foundational activities for storm planning, read:

Module 1. Tree Risk Assessment and **Module 2. Standing Contracts**

Community Forestry Academy, Link: https://communityforestry.academy/courses/community-planning-for-the-urban-forest-strike-team/





Resources

Community Forestry Academy.
Link: https://communityforestry.academy/courses/community-planning-for-the-urban-forest-strike-team/

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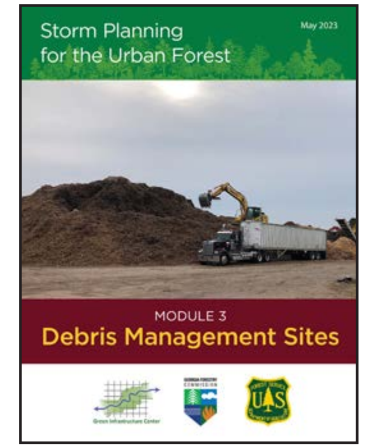

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