Annex XII. Disaster waste management contingency planning

Purpose

These guidelines provide detailed instructions on developing a contingency plan for disaster waste.

They are an annex to the broader Disaster Waste Management Guidelines developed by the Joint UNEP/OCHA Environment Unit and the Swedish Civil Contingencies Agency (MSB).

Overview

Natural disasters can generate tremendous quantities of waste. Communities and national agencies will find it easier to manage disasters if they have an up-to-date disaster waste contingency plan (contingency plan) that describes the types, locations, and capacities of existing solid waste management capacities as well as the practices and policies to be followed to tackle disaster waste. A contingency plan can:

- reduce the impacts of disaster waste in future emergencies;
- save money;
- increase control over waste management;
- improve administrative efficiency;
- protect the environment; and
- serve as a resource document in negotiating technical and financial assistance.

A contingency plan should address issues beyond initial waste removal, help to prioritize waste management options, and include a strategy for recycling and reuse of materials. These guidelines should be used by national authorities in a disaster-prone or disaster-affected country or by outside experts who have been requested to provide assistance to these countries.

The output should be a commonly understood plan for how to manage waste from future disasters. Normally, the contingency plan would be an adjunct to, or consistent with, a larger disaster contingency planning process.

Components of a Disaster Waste Management Contingency Plan

These guidelines do not provide an exhaustive description of contingency plan contents. Rather, they describe the main elements or topics that should contribute to or be included in an effective contingency plan. These are:

1. Pre-planning activities.
2. Ensuring governmental coordination.
3. Identifying likely waste and debris types.
4. Forecasting amounts of waste and debris.
5. Listing applicable national, and local environmental regulations.
6. Preparing an inventory of current capacity for waste and debris management and determining waste and debris tracking mechanisms.
7. Pre-selecting temporary waste and debris storage sites.
8. Identifying equipment and administrative needs.
9. Pre-negotiating contracts.
10. Developing a communications plan.
11. Creating a disaster debris prevention strategy.
12. Creating a debris removal strategy.
13. Identifying harmful materials and preparing hazardous waste management recommendations.
14. Researching recycling options.
15. Researching waste-to-energy options.
16. Evaluating disposal options.
17. Evaluating open burning options.

Each of these elements is described in more detail below. Users of this document should work through each of the applicable elements, and aim to have a final document with contents resembling those in the Table XII.a.

Operational requirements for waste sites

General environmental, safety, and logistical considerations include:

- **Environmental monitoring.** Areas to be used to stage vegetative debris do not typically require groundwater monitoring, but should be monitored for fires. Areas to be used to stage mixed rubble or hazardous waste may need more extensive monitoring. Consult with the national authorities for recommendations.
- **Removal of debris from the site in a timely manner.** Bio-degradeable, mixed, harmful, and hazardous waste should not be stored for extended periods of time. These types of waste should be removed daily or as soon as possible to prevent odors, vectors, human health hazards, and/or harmful emissions.
- **Limiting site access.** Some wastes that present higher levels of concern should have additional storage controls and security measures.
- **Evaluating traffic logistics** on and around the storage site.
- **Minimizing noise disruptions** to acceptable hours.

Consider the following safeguards **for hazardous waste sites**:

- Area should be covered with two layers of plastic sheeting, tarps, or a concrete pad.
- Fence off the area.
- If possible, surround fenced off area with absorbent booms (to absorb any potential leaks) or sandbags (to prevent spills from seeping into the ground).
- Use wooden pallets to raise collection bins off the ground and ascertain potential leaks.
- Provide adequate space for walking/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/lids or cover the entire hazardous waste collection site with a tent to prevent water collecting in bins.
- Cylinders containing compressed gas should be placed upright and be secured.
- Provide sufficient fire extinguishers for the site in case fire breaks out. Four fire extinguishers per 1000 square metres are recommended. They should be in easily accessible locations.

Pre-planning activities

The following activities are recommended before starting on the contingency plan:

1. **Understand requirements.** Understand national requirements for public assistance eligibility and possible approval processes for international assistance.

2. **Assemble a team.** Identify a team of individuals who will work together to prepare the plan. The team should include planning officials, emergency management officials, environmental officials and first responders. If possible, the team should also include officials from communities that have experienced disasters in the past. In some places it may be beneficial to invite officials from neighbouring countries that have experienced disasters.

3. **Design a process for review and development.** The team should establish how the plan will be created and who, beyond the team, should review it, such as neighbouring communities and NGOs, waste haulers and other stakeholders.

4. **Develop a schedule for updating.** A schedule for updating should be incorporated in the contingency plan to ensure that it reflects current practices, policies and current organizational structures.

Coordinating external assistance at government level

In an event of disaster, local officials must know whom to contact for assistance and understand the roles and responsibilities of external agencies involved in the response to effectively coordinate recovery efforts. This is true for disaster waste and emergency coordination in general. Effective coordination requires:

1. a commonly understood description of who is responsible for what, where and when and an identification of relationships between relevant authorities and/or departments;

2. an up-to-date contact list with the names and emergency contact details of relevant people;

3. the designation of a waste manager and support team;

4. the identification of available resources (staff and equipment); and

5. a description of any existing mutual aid agreements with agencies/organizations involved in response.

The following checklist is useful for preparing for a coordinated response:

Step 1: Develop a document that lists authorities that are relevant to DWM and describes the interdepartmental relationships between them. For example: who has overall responsibility for disaster waste following a disaster? What entities are engaged in the physical cleanup? What are the relationships between national, regional and local government?

Step 2: Develop a contact list of all key stakeholders. Identify who will manage the list to ensure that it is current.

Step 3: Based on the above relationships, designate a waste management team whose lines of authority are clear.

Step 4: Outline and evaluate potential specific disaster scenarios and develop response action checklists by disaster for debris and waste management.

Step 5: Ensure relevant actors are familiar with emergency plans, procedures and standardized emergency management systems through dissemination and training where needed.

Step 6: Identify local, regional and national agencies involved in disaster waste management and involve them in the planning process where possible.

Identify types of debris and forecast amounts

The materials that will likely make up the disaster waste stream should be evaluated so that appropriate measures can be put in place to address them in the event of a disaster. In order to guide the considerations needed a tool for waste needs assessment in the emergency phase (Table XII.a) is attached.

Some types of debris result more frequently from certain types of natural disasters. Typhoons and hurricanes, for example, create different waste and different volumes of waste than floods or volcano eruptions.

Table XII.b. describes the characteristics of debris that can be expected from a variety of hazards.

Forecast the amount of disaster waste

The following can be used to estimate likely amounts of disaster waste:

- **Household waste.** Day-to-day household waste will be approximately the same per capita as before the disaster.

Table XII.a. A tool for waste needs assessment in the emergency phase

People in the affected area				comments
Estimate percentage			%	
IDP camps				
How many IDP camps are established?			Nos	
Estimate percentage of population staying in the camps			%	
How is waste management arranged?			Nos	
Collection				//bins// // street pile// // others -what//
Treatment				//dump-sites// //open burning// //others – what//
Estimate the amount of IDP waste collected			%	
Immediate needs				
Condition of buildings				comments
Estimate total destruction as percentage			%	
Estimate intact buildings as percentage			%	
Which is the main construction material used in the disaster area?				//Concrete// //bricks// //board// // tins//
Estimate the total amount of rubble and debris from buildings			m3	square metres covered x high
Immediate needs				
Conditions of other infrastructure. Are:	yes	no		comments
Roads and streets functioning?			%	If not, describe damage and debris potential in separate sheet
Water distribution functioning?			%	
Waste water collection and drainage functioning?			%	
Land line telecommunications functioning?			%	
Mobile telephones functioning?			%	
Internet functioning?			%	
Electricity distribution functioning?			%	
Immediate needs				

Continued...

Table XII.a, continued				
Hospitals and health care centers	Yes	No		Comments
Are hospitals and clinics functioning?				
Is their waste being managed?				If yes go to health-care sheet
Is there information about infectious waste?				If yes go to health-care sheet
Is there information about other health-care waste?				
Are there temporary clinics/hospitals?				If yes go to health-care sheet
If so, many beds (capacity)do they have?				
Is there any information about waste collection from the temporary hospitals/clinics				if yes go to health-care sheet
Immediate needs				
Industries and other commercial activities	Yes	No		comments
What kind of industries were located in the disaster area?				Give details on the industrial waste sheet!
Are they intact?				
Is there any information about input chemicals?				Give details on the industrial waste sheet!
Is there any information about hazardous waste?				Give details on the industrial waste sheet!
Immediate needs				
Municipal waste management	Yes	No		comments
To what extent has it recovered and is it functioning?			%	
Are waste management vehicles intact?			nos	if no: describe the problems
Are employees alive and still in the area?				
Is there fuel available for the vehicles?				
Is the dumpsite intact?				If no: describe the problems
Are the access-roads to the dumpsite intact?				If no: describe the problems
Are there any temporary dump-sites?				
If so, where are they located?				
Are there any other waste treatment plants in the area?				If yes: describe
Immediate needs				
Hazardous waste	Yes	No		
HW among industrial debris and rubble				be aware of the risk for asbestos!
HW from industries				
Hazardous and electronic waste from telecom				
Hazardous and electronic waste from electrical grid				
Hazardous and electronic waste from municipal waste				
Prompt needs				

Table XII.a, continued	
Infrastructure debris assessment	
	Notes
Roads	
Tar road debris	
Dirt road debris	
Streets	
Tar street debris	
Mud street debris	
Water distribution system	
Debris from water works	
Pipes	
Wastewater collection system	
Debris from waste waster treatment plants	
Pipes	
Other drainage systems	
Debris from broken drains	
Waste clogging the drains	
Landline telecommunication	
Poles	
Dig down cable	
Open hanging cable	
Mobile telecommunication	
Antenna masts	Electronic waste on downed masts
Others	
Internet	
Dig down cable	
Open hanging cable	
Electricity grid	
Poles	
Dig down cable	
Open hanging cable	
Transformers	Electronic waste, transformer oil

Table XII.a, continued	
Healthcare waste assessment	
Estimate from a few hospitals/clinics	Notes
Is the waste taken care of?	
Segregation?	
Collection?	
Treatment?	//dump-sites// //engineered dump-sites// //incineration//
Is there any information about infectious waste?	
Segregation?	
Collection?	
Treatment?	//dump-sites// //engineered dump-sites// //incineration//
Is there any information about other waste from hospitals and clinics?	
Segregation?	
Collection?	
Treatment?	//dump-sites// //engineered dump-sites// //incineration//
Are there any temporary clinics/hospitals?	
How many beds do they cover?	
Estimate the generation of healthcare waste	
Estimate the composition of the waste	
Is there any information about waste collection from the temporary hospitals/clinics	
Segregation?	
Collection?	
Treatment?	//dump-sites// //engineered dump-sites// //incineration//

Table XII.a, continued					
Industrial waste assessment					
This form is to map the most immediate facts about the industries. Fill in for all facilities for which you can gather details. The information will serve as indications for waste prioritization. There might be fluids stored in tanks or oil drums. Such fluids should be considered hazardous until more is known. Rubble from collapsed industries may be contaminated with hazardous material such as asbestos and chemicals.					
	Yes	No	Indication	Part of disaster waste	List
Name of the plant/equivalent					
Used raw material					
Used energy sources					
Products					
Normal flow of waste					
Composition					
Known generation of hazardous waste					
Source of disaster waste?			m^3		
Disaster rubble			m^3		
Name of the plant/equivalent					
Used raw material					
Used energy sources					
Products					
Normal flow of waste					
Composition					
Known generation of hazardous waste					
Source of disaster waste?			m^3		
Disaster rubble			m^3		
Name of the plant/equivalent					
Used raw material					
Used energy sources					
Products					
Normal flow of waste					
Composition					
Known generation of hazardous waste					
Source of disaster waste?			m^3		
Disaster rubble			m^3		
Name of the plant/equivalent					
Used raw material					
Used energy sources					
Products					
Normal flow of waste					
Composition					
Known generation of hazardous waste					
Source of disaster waste?			m^3		
Disaster rubble			m^3		

Table XII.b. Hazard types and their waste characteristics

For the purpose of establishing a Disaster Waste Management Contingency Plan, disaster waste comprises:	
Earthquakes	Structures collapse *in-situ*, i.e. floor slabs collapse on top of each other, trapping waste within damaged buildings and structures. This can lead to challenges in sorting out hazardous waste (e.g. asbestos) from non-hazardous (e.g. general building rubble). Handling waste often requires heavy machinery, which communities may not be able to afford or have difficulty to access. Collapsed buildings may overlap across streets, making access difficult for the search and rescue and relief operations. Quantities of waste are high compared to other disaster types since all building contents normally become waste.
Flooding	Floods often lead to mass displacement, which in turn requires shelters and camps and leads to large volumes of household wastes. Initial damage depends on the structural integrity of infrastructure, while building contents are normally damaged extensively. Mould may be present and timber may have begun to rot. Buildings are typically stripped by owners and waste placed on roads for collection. Waste is often mixed with hazardous materials such as household cleaning products and electronic goods. Flooding may bring mud, clay and gravel into affected areas, making access difficult once the floodwater recedes. Removal may be required for relief and recovery operations. The mud, clay and gravel may be mixed with hazardous materials, requiring further assessment before dumping.
Tsunami	Strong tsunamis can cause widespread damage to infrastructure, spreading debris over large areas. Debris is often be mixed with soils, trees, bushes and other loose objects such as vehicles. This makes waste difficult to handle and segregate.
Hurricanes typhoons cyclones	Strong winds can tear the roof off buildings, after which walls may collapse. Poorly constructed houses and huts can 'fold' under roof tops. Even brick and concrete walls may collapse. Waste is spread across over open land, streets, and marketplaces. This roofing materials, small items and dust carried by the wind. This may cause serious problems where asbestos is present Ships and boats are often thrown ashore and destroyed, requiring specialized waste management. Vessels that sink in harbours need to be removed. Electrical and telephone grids as well as transformers containing oil and PCBs may be destroyed.
Conflict – short-term	Intense, short-term conflicts can involve rockets, missiles and bombs, which, combined with land combat, result in damage to buildings and infrastructure, key strategic installations being bombed and/or widespread damage to industrial and residential areas. Damaged infrastructure is often burnt, resulting in the destruction of most internal furnishings and fittings. This reduces the quantities of debris to be managed and leaves primarily non-flammable items such as concrete, bricks and stones. Bridges, roadways, railway structures etc. are often targeted. Their clearing requires heavy machinery such as excavators and bulldozers. Waste collection vehicles may be damaged or be commandeered for military purposes. Unexploded ordnance (UXO) including undetonated landmines may be present among waste.
Conflict – protracted	Protracted conflicts share similarities with short-term, intense conflicts but there is often more widespread damage to building and infrastructure, and increased use of landmines on or near strategic roadways and facilities. There is also a risk that waste management staff and labourers have fled, been killed or injured.

- **Waste from Internally Displaced Person (IDP) camps.** If people are moved to IDP camps the majority of waste will be produced there, and special measures for waste management must be put in place since camp waste may include new items with increased packaging such as plastic bottles. Generally, IDP camp per capita waste generation corresponds to urban waste generation before the disaster.

- **Rubble.** Forecasting the amount and types of rubble generated during disasters helps planners to understand the scope of effort that will be required to ensure effective handling. These estimates can be based on previous experience or be made using forecast tools. Due to the unpredictable nature of disasters, no tool will be completely accurate. The USACE Hurricane Debris Prediction Model[1] helps determine the approximate volume of debris from a storm event using the formula **Q = H*(C)*(V)*(B)*(S)** where:

  Q = estimated debris total generated in cubic yards equal to cubic metres

  H = number of households, or population/3 (household = population divided by 3)

  C = hurricane category factor (cat1 = 2, cat2 = 8, cat3 = 26, cat 4 = 50, cat5 = 80)

  V = density of vegetation (1.1 for light, 1.3 for medium, 1.5 for heavy)

  B = percentage of commercial structures (1.0 for light, 1.2 for medium, 1.3 for heavy)

  S = precipitation factor (1.0 for none to light, 1.3 for medium to heavy)

The predicted accuracy is ±30%. This is a US model and will be even more approximate when used elsewhere but can provide a sense of the volume of rubble to be expected.

The following can also be used as a guide for the amount of rubble that be expected per building"

- Wooden house 80 kg/m2
- Single storey modern brick house 736 kg/m2
- Single storey commercial building 746 kg/m2
- Multi-storey commercial building 817 kg/m2

Using these figures, a modern brick house with 86 m2 floor area will generate an estimated 63 tons of debris and rubble.

List applicable national and local environmental regulations

Contingency planners must be familiar with relevant national and local environmental and planning regulations. An effective contingency plan lists regulations and explains how to manage waste according to those regulations. This part of the contingency plan must include an up-to-date contact list of relevant waste management and environmental officials who can be contacted in the event that guidance on the regulations is needed during cleanup.

Inventory current capacity for waste management and determine waste tracking mechanisms

After the amount and type of disaster waste is estimated, waste management capacity in the region or disaster-prone area must be evaluated.

Solid waste management facilities for disposal, recycling, reuse and combustion must be inventoried, along with their capacity to handle different types of waste. There is

[1] *USACE model results should be used while keeping in mind three considerations: first, the volume of debris estimated is a total amount of debris from a storm largely based on residential sources with limited consideration of non-residential sources. Second, the model cannot take into account minor variations in storm intensity. Third, the model does not account for debris that might result from flooding caused by storm-related rainfall.*

a particular need to understand the capacity of hazardous waste and health-care waste management facilities.

The capacity of the facilities that manage waste in excess of normal or permitted daily load should also be evaluated. Contact details for solid waste facilities within reasonable distance of disaster prone areas should be listed along with the facilities' locations, including global positioning system (GPS) coordinates. Lists of other relevant service providers (e.g. demolition contractors, refrigerant removers, electronics processors, etc.) should also be included.

Natural disasters can impact transportation routes. It is therefore necessary to evaluate a range of options for transporting waste. Depending on the local context, consider other forms of transportation beyond trucks, such as tricycles and donkey carts. Depending on the expected amount of waste, long distance transportation needs can be considered.

If there is insufficient capacity to manage the predicted amount of waste, facilities outside of the immediate area can be contacted, and ad hoc solid waste management facilities can be identified.

Identifying these areas in advance allows time to undertake any necessary environmental assessments.

Mutual aid agreements can be established with neighbouring communities or municipalities in advance of a natural disaster to ensure additional waste management capacity.

The military normally represents a substantial capacity in waste and debris hauling, as well as transportation. It can, where appropriate, be involved in the contingency plan.

The contingency plan should identify how waste can be monitored and tracked. Tracking is important to: 1) determine the amount of waste from the disaster 2) determine the capacity being used and remaining at various waste management locations and 3) pay waste haulers, who are normally paid according to the quantity of waste transported.

Contract waste haulers can be identified in advance.

Therefore, provisions in the contingency plan can be made for measuring truck carrying capacity and assigning each truck a number before the truck is allowed to collect disaster debris so that the amount it collects can be tracked. Trucks can then be monitored at the receiving facility.

Pre-select debris management sites

A single typhoon, hurricane or flood can generate more waste than some communities typically manage in a year, making it important to pre-select temporary sites for storing, sorting, and processing waste. Parks, playgrounds, sport-fields may be designated for this purpose.

Locating temporary deposit sites must take in account, however, that open and well prepared sites close to the damaged areas are also potential sites for IDP camps.

As a rule of thumb **400,000 square metres of land are needed to process one million cubic metre of waste**. This will vary according to the processing method used.

Sites should:

- not be in a floodplain or wetland;
- be of appropriate size for anticipated waste;
- have appropriate topography and soil type. Work with national and local environmental agencies to determine what this means in the area under consideration;
- be located at a safe distance from potable water wells and rivers, lakes, and streams. Work with national and local environmental agencies to determine appropriate setback distances;
- have controls to mitigate storm water runoff, erosion, fires and dust;

- be free from obstructions such as power and pipe lines;
- have limited access with only certain areas (e.g. for drop-off) open to the public;
- be located close to the disaster-prone area, but at a safe distance from residences, infrastructure, and businesses that could be affected by site operations during the recovery period; or
- preferably be on public land because approval for this use is generally easier to obtain. However, private land may be convenient and logistically necessary. In this case, consider agreements with private land owners in advance to ensure the use of the areas needed.

The condition of temporary sites should be evaluated and documented prior to use. It is advisable to assess the soil, groundwater and/or surface water prior to receiving waste and to re-establish pre-existing conditions once the site is no longer needed.

Identify equipment and administrative needs

Contingency plans should identify the types of equipment and supplies needed. An indicative list is provided below. If a large number of vehicles and fuel-dependent equipment is needed, consider possible implications from a fuel shortage due to the disaster.

Primary needs for initial response:

- safety items/personal protective equipment (first aid kits, safety vests, work gloves, protective boots etc.)[2];
- torches and flashlights;
- chainsaws;
- debris/earth moving equipment, such as skid-steer loaders, front loaders, excavators and grapplers;
- dump trucks and roll-off trucks;
- flares;
- flags, small and brightly coloured;
- fuel;
- generators;
- handheld Geographical Positioning System (GPS) units to record waste locations;
- handheld radios, cell phones, satellite phones, and/or wireless handheld devices;
- batteries;
- notebooks and cameras;
- road signs to direct debris hauler traffic; and
- vehicle repair equipment.

Secondary needs for waste processing:;

- mobile incinerator for infectious waste or construction material to build a temporary incinerator.;
- cranes with cables and magnets;
- dumpsters and hoppers;
- forklifts;
- jack hammers;
- jaw crushers and/or compactors;
- pallets;

[2] *A website provided by the US Occupational Safety and Health Administration (OSHA) include a "Hurricane eMatrix" on worker safety during the management of disaster debris. The tool identifies types of necessary personal protective equipment and operational considerations. Although the matrix was designed for use after hurricanes, much of the recommendations can apply to the management of debris generated from other natural disasters. The list below is an interpretation for this document.*

- plastic sheeting;
- sealable plastic drums;
- wood grinders; and
- air quality monitoring equipment.

Tertiary needs for processing large volumes of rubble:;

- crushers;
- conveyors;
- vibrating screen sorters; and
- air curtain incinerators.

Administrative needs

In the aftermath of a natural disaster, communities need to increase numbers of telephone calls concerning waste management. They also need more staff to train and monitor debris collection contractors and to troubleshoot. Waste management sites require additional staff to ensure that waste is being managed properly. Cities and communities should consider **cross-training their existing staff** to carry out several responsibilities related to disaster response. They should also identify sources of temporary labour, which can contribute to post-disaster livelihood.

Pre-negotiated contracts

Pre-negotiated contracts should be considered for additional services that communities cannot provide, for example debris removal, storage, sorting, recycling, processing, marketing, and disposal. Pre-negotiated contracts will help to guarantee capacity and may result in cost savings compared to post-disaster price negotiations. Furthermore, waste management can begin more quickly than if contract negotiations are required after the natural disaster. If pre-negotiated contracts are not feasible, consider including a list of prequalified contractors from whom bids can be solicited directly after the disaster.

Mutual aid agreements may allow equipment, services, and expenses to be shared with communities that have capacity to share. Consider contacting other local governments in advance to establish mutual aid agreements.

Communications plan

A contingency plan should include plans for internal and external communications. During recovery, communities will have to communicate with stakeholders including waste management teams, government agencies, commercial enterprises, residential waste haulers, and the public regarding waste removal. The communications plan should describe what information will be provided and how communication will occur. Elements of an internal, operational communications plan include:

- describing the chain-of-command, as well as how decisions will be communicated;
- providing instructions to the debris team in order to ensure proper debris management;
- distributing the contingency plan to ensure it can be implemented quickly and smoothly. electronic versions on CDs or memory sticks should be distributed as well as hard-copies in the event computers are not accessible after the disaster;
- ensuring that the debris management team is familiar with the contingency plan ahead of the disaster;
- developing a communication mechanism with relevant government agencies (e.g. police, military forces, health officials, and other emergency responders) to ensure waste is collected in a way that protects public safety;
- ensuring that the contingency plan is shared with the region, national authorities and neighbouring communities. this will ensure that the plan is accessible post-disaster; and
- establishing a communication strategy with major commercial enterprises that may generate large amounts of disaster waste. this could include contact information, physical location, and a list of hazardous and nonhazardous waste that could be generated.

Communicating with the public

Properly informing the public is one of the most important elements in planning for disaster waste management. Citizens must understand the cleanup process, and feel ownership over it. Consider placing the contingency plan on the internet and seeking public comment, or seek comment in other ways. Allow the public to review the document and understand how debris and other management will occur before a natural disaster. This can provide time for discussion and revisions to the plan based on public concerns.

A public information programme can follow these steps:[3]

1. Identify target groups.
2. Establish a public information center to handle questions from the public.
3. Develop contact lists for the media, or refresh existing lists.
4. Set up, if possible, a hotline for the public to call regarding disaster waste management programmes and/or debris pickup.
5. Ensure coordination of outreach materials for debris management programmes with relevant authorities.
6. Advertise recycling and diversion programmes.
7. Determine the need for interpreters and translators of the contingency plan.
8. Produce and provide fact sheets to the public.
9. Develop public information campaigns.

All communication should be timely, consistent, updated, and use language that is not overly technical. Discuss the use of free public service advertising with local media companies to communicate instructions in the event of a natural disaster. Depending on the type and severity of the natural disaster, however, a city/community might lose electricity, telephone service, radio broadcasting capability, or newspaper service. More than one method of communication should therefore be prepared.

Create a disaster waste reduction strategy

Disaster waste reduction and prevention should be considered in the contingency plan. Full prevention may not be possible but some measures can at least reduce waste. These include an outreach programme to educate the public on how they may decrease the amount of damage that their property might suffer in a natural disaster. An evaluation of building codes and planning by local officials may be prudent and help to determine whether the community can withstand disasters anticipated in the that area. Examples of actions include:

Hurricanes. Residents can be advised to trim back yard trees on their property and remove dead or diseased trees. Utility crews can trim vegetation around power lines and remove trees that may interfere with important power and pipe lines. Outdoor belongings, such as patio furniture and grills can become projectiles and should be brought inside or secured. Advice can be given on what to do for roofs, windows and doors, screen enclosures, attic vents and other openings, home structure, the surrounding environment, and other features of a house. These measures will also help to reduce the quantity of falling branches, uprooted trees, and vegetation that can cause destruction to infrastructure.

Earthquakes. In some cases houses can be anchored to their foundations to help prevent them from moving. Strengthening weak walls, foundations and chimneys can prevent horizontal movement of homes and subsequent damage.

Floods. Outdoor belongings such as patio furniture and grills can be brought inside or secured outside using ground anchors or straps. Waste from drains, culverts,

[3] *10 steps interpreted from "Integrated Waste Management Disaster Plan" (State of California 1997)*

streams and channels should be removed to allow floodwaters to flow freely.

Volcanoes. Volcanoes create ash and molten lava debris. Land-use and building ordinances that restrict construction in volcanic areas can reduce debris generated as a result of a volcano.

Debris removal strategy

There are numerous ways to handle and transport waste for processing or disposal.

The main transportation options are[4]:

- **Push mechanisms**: paying a contractor to bring the debris to the treatment site; or,
- **Pull mechanisms**: paying per load of debris brought to the treatment site at a set rate.

During the contingency planning phase, both options should be considered since post-disaster constraints would be unknown and options would need to be left open.

If debris quantities are likely to be spread throughout a geographical area and the transportation of the waste to a single area is not feasible, then temporary storage sites can be established. These are temporary depots to which waste can be brought. Once enough waste has been collected (generally more than 1,500m^3) the waste can be processed.

Non-recyclable debris such as furnishing, personal belongings, packaging, mixed waste and hazardous materials are typically disposed of at the local landfill or dumpsite.

Harmful materials identification and hazardous waste management recommendations

Hazardous waste such as automotive and marine batteries, pesticides and their containers, explosives, lubricants, fuels and similar fluids, solvents, paint thinners and strippers and liquefied gas containers may be generated in a disaster. The contingency plan should include measures for controlling and diverting hazardous waste from general waste, including handling procedures and training. This helps to avoid the release of hazardous materials. Relevant officials should be contacted to determine if a emergency hazardous waste storage permit or other facility approval is required. All regulated hazardous wastes should be managed in an appropriate facility that complies with the local regulations.

Household items such as motor oil, automobile batteries, paints and solvents, household cleaners and drain openers, pesticides, and compressed gas tanks should be segregated for special handling. Residents can be directed to bring hazardous waste to specified locations and be advised not to mix hazardous waste with other waste.

Asbestos-containing material, such as asbestos pipe wrap, siding, ceiling tiles and other building materials may be present. There are often regulations governing the removal and management of asbestos. These may affect the demolition of buildings and waste removal. This must be considered in advance.

Regulated asbestos-containing material must be removed prior to demolition under the supervision of a qualified person. The material must be wetted throughout the process and disposed of properly. This includes labelling, proper transportation, tracking, recordkeeping, and disposal at an appropriate site. To the extent that an entity is dealing with debris from structures already demolished by a natural disaster (as opposed to human demolition), asbestos regulations may not be applicable or may be relaxed but safe procedures must nevertheless be followed.

[4] *"A Brief Guide to the management of Building Waste Materials in disaster response operations", a booklet developed in collaboration between ProAct Network, Shelter Centre and Disaster Waste Recovery (DWR).*

Table XII.c. Reuse and recycling options for typical disaster wastes

Waste material	Description and source	Reuse	Recycle
Food waste	Present in camp and household waste. Shrubs, trees, cuttings etc can also be included in this category	Limited scope for reuse	Compost can be used to supplement agricultural requirements
Plastics	Present mainly in camp and household waste streams	Limited scope for reuse	Plastics may need to be sorted into various types. They can then be baled or pelletized and sold
Excreta	Excreta from camps can be composted under certain controlled mechanisms	No scope for reuse	Compost can be used to supplement agricultural requirements
Paper & cardboard	Present in camp and household waste streams	Limited scope for reuse except as kindling	Pulp the paper and cardboard with subsequent dewatering. Dried pulp can be compressed into briquets for heating/cooking
Glass	Present in camp and household waste streams	Limited scope for reuse except with thorough mechanized sterilization/ cleaning	Can be collected and recycled where facilities exist
Debris/rubble	Generated anywhere buildings are demolished	Reuse bricks and stones for reconstruction purposes	Concrete, bricks and stones can be crushed for road base and construction material
	Timber	Timber can be reused for furniture making	Timber can be used to make charcoal for heating/cooking
	Metals	Limited reuse since strength of metal cannot be guaranteed	Scrap metal sold for smelting into new metal products

Asbestos can be disposed at dumpsites or landfills planned for municipal solid waste and construction and demolition rubble. Such landfills should be provided with handling procedures for the asbestos-containing materials.

Power transformers may contain polychlorinated biphenols (PCBs). Transformers should therefore be mapped, and the contingency plan should include provisions for waste management personnel to notify local electric utility staff if they are damaged in a disaster. If a transformer appears to be leaking and does not have a sticker declaring that it is PCB-free, personnel should immediately notify the local environmental health office and the electric utility and restrict access to the area. In the absence of information to the contrary, it should be assumed that all transformers contain PCBs.

Storage tanks may contain hazardous substances, which can pose health, safety, and environmental risks. These should always be handled 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, waste removal activities should be stopped, the area sealed off, and local authorities contacted for assistance.

Firearms and ammunition may be part of the waste stream and prompt collection is important to ensure safety.

Recycling options

Recycling waste following disasters has numerous benefits:

- reduced cost of disposal and burden on disposal facilities;
- employment opportunities for affected communities; and
- recycled material can be fed back into the rehabilitation and reconstruction process.

Post disaster waste management can also be an opportunity to improve existing solid waste management by supporting a more integrated approach to waste management.

Table XII.c. presents recycling options for various types of disaster waste.

Open burning options

Open burning is normally a last resort, but may be an option where infectious waste disposal is required. Treated wood should be removed from the waste stream before burning. No materials containing asbestos should be burned at debris management sites.

Open burning should be conducted in accordance with best available practice to protect human health and the environment. Typically, only vegetative debris should be burned in an open pit. Vegetative debris, dead animals and segregated clean building material may be burned in an Air Curtain Incinerator (ACI).

This method consists of a pit constructed by digging below grade or building above grade (if there is a shallow groundwater table) and a blower. The blower must have adequate air velocity to provide a "curtain effect" to hold smoke in and to feed air to the fire below. The pit must have a precise width, depth and length to compliment 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. They require little or no maintenance, whereas earth or stone pits which are susceptible to erosion. Portable ACI units are suitable for areas with shallow groundwater tables, sandy soils, and where smoke must be kept to a minimum.