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# Best Practices for Management of Biocontaminated Waste


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# Best Practices for Management of Biocontaminated Waste

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U.S. Environmental Protection Agency
National Homeland Security Research Center
Decontamination and Consequence Management Division
Research Triangle Park, NC

## Disclaimers

The U.S. Environmental Protection Agency through its Office of Research and Development managed the research described here. This work was performed by Battelle under Contract No. EP-C-15-002 Task Order 0001. It has been subjected to the Agency's review and has been approved for publication. Note that approval does not signify that the contents necessarily reflect the views of the Agency.

The cleanup process described in these best practices does not rely on and does not affect authority under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601 et seq., and the National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. This document is intended to provide information and suggestions that may be helpful for waste handling efforts and waste management operations after a biological incident and should be considered advisory. The best practices in this document are not required elements of any rule. Therefore, this document does not substitute for any statutory provisions or regulations, nor is it a regulation itself, so it does not impose legally-binding requirements on EPA, states, or the regulated community. The lessons and recommendations herein may not be applicable to each and every situation.

Questions concerning this document or its application should be addressed to:

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## List of Acronyms and Abbreviations

| | |
|---|---|
| **ACM** | Asbestos containing material |
| **AHU** | Air handling unit |
| **APHIS** | Animal and Plant Health Inspection Service |
| **AVMA** | American Veterinary Medical Association |
| **BBP** | Bloodborne Pathogens |
| **BOTE** | Bioresponse Operational Testing and Evaluation |
| **BROOM** | Building Restoration Operations Optimization Model |
| **C&D** | Construction and demolition |
| **CalEPA** | California Environmental Protection Agency |
| **CBR** | Chemical, Biological, Radiological |
| **CBRN** | Chemical, Biological, Radiological, and Nuclear |
| **CDC** | Centers for Disease Control and Prevention |
| **CERCLA** | Comprehensive Environmental Response, Compensation, and Liability Act |
| **CFR** | Code of Federal Regulations |
| **$ClO_2$** | Chlorine dioxide |
| **DeconST** | Decontamination Strategy and Technology Selection Tool |
| **DHS** | U.S. Department of Homeland Security |
| **DOHMH** | Department of Health and Mental Hygiene |
| **DOT** | Department of Transportation |
| **EPA** | U.S. Environmental Protection Agency |
| **ERLN** | Environmental Response Laboratory Network |
| **ESF** | Emergency Support Function |
| **EtO** | Ethylene oxide |
| **EVD** | Ebola viral disease |
| **FASTMap** | Fast Analysis and Simulation Team Map |
| **FEMA** | Federal Emergency Management Agency |
| **FFR** | Filtering Facepiece Respirator |
| **FIELDS** | Fully Integrated Environmental Location Decision Support |
| **FIFRA** | Federal Insecticide, Fungicide, and Rodenticide Act |
| **FSMA** | Food Safety Modernization Act |
| **GAO** | Government Accountability Office |
| **GPS** | Global Positioning System |
| **$H_2O_2$** | Hydrogen peroxide |
| **HASP** | Health and Safety Plan |
| **HAZMAT** | Hazardous Materials |
| **HAZWOPER** | Hazardous Waste Operations and Emergency Response |
| **HEPA** | High Efficiency Particulate Air |
| **HHS** | Health and Human Services |
| **HMR** | Hazardous Materials Regulation |
| **HPAI** | Highly Pathogenic Avian Influenza |
| **HVAC** | Heating, Ventilation, and Air Conditioning |
| **HW** | Hazardous Waste |
| **ICLN** | Integrated Consortium of Laboratory Networks |
| **ICS** | Incident Command System |
| **IC/UC** | Incident Command/Unified Command |
| **I-WASTE DST** | Incident Waste Decision Support Tool |

| | |
|---|---|
| **JFO** | Joint Field Office |
| **LRN** | Laboratory Response Network |
| **MAA** | Mutual Aid Agreement |
| **MSW** | Municipal Solid Waste |
| **NASAAEP** | National Alliance of State Animal and Agricultural Emergency Programs |
| **NAU** | Negative Air Unit |
| **NCP** | National Contingency Plan |
| **NGO** | Non-Governmental Organization |
| **NHSRC** | National Homeland Security Research Center |
| **NIMS** | National Incident Management System |
| **NIOSH** | National Institute of Occupational Safety and Health |
| **NISAC** | National Infrastructure Simulation and Analysis Center |
| **NRF** | National Response Framework |
| **ORCR** | Office of Resource Conservation and Recovery |
| **ORNL** | Oakridge National Laboratory |
| **OSHA** | Occupational Safety and Health Administration |
| **P&DC** | Processing and Distribution Center |
| **PAPR** | Powered Air-Purifying Respirator |
| **PATH/AWARE** | Prioritization Analysis Tool for All-Hazards/Analyzer for Wide Area Restoration Effectiveness |
| **PCB** | Polychlorinated biphenyl |
| **PIO** | Public Information Officer |
| **PHMSA** | Pipeline and Hazardous Materials Safety Administration |
| **PNNL** | Pacific National Northwest Laboratory |
| **POTW** | Publically Owned Treatment Works |
| **PPE** | Personal Protective Equipment |
| **PSA** | Public Service Announcement |
| **RCRA** | Resource Conservation and Recovery Act |
| **SADA** | Spatial Analysis and Decision Assistance |
| **SAM** | Standard Analytical Method |
| **SCBA** | Self-Contained Breathing Apparatus |
| **SME** | Subject Matter Expert |
| **TWG** | Technical Working Group |
| **USACE** | U.S. Army Corp of Engineers |
| **USDA** | U.S. Department of Agriculture |
| **USPHS** | U.S. Public Health Service |
| **VHP** | Vaporous Hydrogen Peroxide |
| **VSP** | Visual Sample Planning |
| **WAC** | Waste Acceptance Criteria |
| **WARRP** | Wide Area Recovery and Resiliency Program |
| **WEST** | Waste Estimation Support Tool |
| **WERF** | Water Environment Research Foundation |
| **WHO** | World Health Organization |
| **WM** | Waste Management |
| **WMP** | Waste Management Plan |
| **WWTP** | Wastewater Treatment Plant |

## Glossary

**All-Hazards** – The spectrum of all types of hazards, including accidents, technological events, natural disasters, terrorist attacks, warfare, and chemical, biological (including pandemic influenza), radiological, nuclear, or explosive events.

**Characterization** – Facility or site sampling, monitoring, and analysis activities to determine the extent and nature of the release. Characterization provides the basis for acquiring the necessary technical information to develop, screen, analyze, and select appropriate cleanup techniques; characterization can also provide the basis to estimate the volume of waste to be generated. This is distinct from Waste Characterization (defined below), which is the process of determining whether a waste meets the definition of hazardous waste under RCRA.

**Code of Federal Regulations (CFR)** – The codification of the federal regulations published in the Federal Register by the executive departments and agencies of the federal government. Each volume of the CFR is updated once each calendar year and is issued on a quarterly basis. See http://www.ecfr.gov/cgi-bin/text-idx?tpl=%2Findex.tpl, Accessed July 5, 2016.

**Incident** – An occurrence caused by either human action or natural phenomena that may cause harm and may require action. Incidents can include major disasters, emergencies, terrorist attacks, terrorist threats, wild and urban fires, floods, spills of hazardous materials, nuclear accidents, aircraft accidents, earthquakes, hurricanes, tornadoes, tropical storms, war-related disasters, public health and medical emergencies, and other occurrences requiring an emergency response.

**Hazardous Waste** – For the purposes of these best practices, a solid or aqueous waste that may cause an increase in mortality or serious illness or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. The Resource Conservation and Recovery Act (RCRA) governs hazardous waste identification, classification, generation, management and disposal in title 40 CFR parts 260 through 273.

**Pre-Incident Waste Management Plan** – A plan that addresses the management of waste generated by all hazards, particularly from homeland security incidents ranging from natural disasters and animal disease outbreaks to chemical spills and nuclear incidents to terrorist attacks involving conventional, chemical, radiological, or biological agents. Given the amount and types of waste that can be generated during an incident, this plan is designed to assist emergency managers and planners in the public and private sectors in preparing for the waste management needs associated with an incident, regardless of the hazard. Experience has demonstrated that incident response would benefit from a pre-incident plan to reduce or eliminate delays in the cleanup and recovery from the incident, as well as decreasing overall costs.

**Resource Conservation and Recovery Act (RCRA)** – A 1976 federal law (42 U.S.C. §6901 et seq.) that gives the EPA the authority to control hazardous waste from the “cradle-to-grave,” including the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of nonhazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances.

**Safety Zone** – Safety or work zones are established primarily to reduce the accidental spread of biological substances by workers or equipment from contaminated areas to clean areas. Safety zones specify the type of operation that will occur in each zone, the degree of hazard at different locations within the release site, and the areas at the site that should be avoided by unauthorized or unprotected employees.

**Sharps waste** – Sharps waste is a form of biomedical waste composed of used sharps, which includes any device or object used to puncture or lacerate the skin. Sharps waste is classified as biohazardous waste and must be carefully handled.

**Staging Area** – A temporary location at or near an incident site that is designated as a support or Cold Zone used to stage personnel and equipment for immediate dispatch to the incident site to support operations. There can be more than one staging area per incident.

**Waste** – Material in gaseous, liquid, or solid form for which no further use is foreseen.

**Waste acceptance criteria** – The terms “contaminated” and “uncontaminated” will be decided according to the cleanup goals and waste acceptance criteria (WAC) of the disposal facilities.

**Waste Characterization** – This is distinct from general Characterization (defined above). Under 40 CFR 261.20-24, wastes can be designated as characteristic (“D” code) hazardous waste based on its properties. A solid waste defined as hazardous because it exhibits one of the following four characteristics: ignitability, corrosivity, reactivity, or toxicity as determined by the toxicity characteristic leaching procedure (TCLP). Wastes that fail the TCLP are deemed hazardous wastes regardless of what process generated the waste.

**Waste Management** – For the purposes of these best practices, the administration of activities that include, but are not limited to, waste collection and characterization, waste segregation and minimization, labeling and packaging, decontamination, recycling, transport, staging, storage, treatment, disposal and tracking and reporting.

**Waste Staging** – Temporarily storing waste for the purpose of accumulation and sorting to facilitate transportation, transfer, treatment and/or disposal, and to keep biological waste from contaminating non-hazardous waste streams.

**Waste Staging Area** – A location at an incident site designated for the temporary accumulation and sorting of biological waste and debris until that waste is manifested and shipped to an off-site disposal facility.

# EXECUTIVE SUMMARY

This document was prepared to provide best practices on the fate and transport of waste management operations after a biological agent incident, including best practices for handling waste after a biological incident. Initially, an extensive literature review was conducted of waste management topics related to types of biological and non-biological incidents such as natural disasters, operational exercises, medical waste handling during a disease outbreak, and the cleanup of sites contaminated by the intentional dissemination of a biological warfare agent. The review included the packaging and handling of biological waste, sampling and analysis for waste classification and identification, worker training, best practices for on-site waste treatment, waste disposal, personal protective equipment (PPE) selection and use, and information on biological agents of interest. The literature review was limited to previously published information from scholarly journals, the EPA, and other state and federal agencies, as well as unpublished, institutional knowledge the EPA has gained during responses to biological agent contamination. This document presents best practices for biocontaminated waste management that incorporates the results from the literature review, but is not a literature review in and of itself. These best practices also cite publicly available online guidance and handbooks that may be considered when responding to a biological agent incident.

The purpose of these best practices is to provide federal, state, territorial, and local waste management entities information on techniques and methodologies that have the potential to improve the handling and management of biocontaminated waste streams after a biological agent incident. These best practices are intended to be general in nature serving as a resource to a variety of biological agents in a variety of situations; however, these best practices also present a specific homeland security scenario – a biological attack with *Bacillus anthracis* – to help illustrate specific waste management considerations.

These best practices also discuss the importance of “pre-incident” waste management planning to potentially improve waste management preparedness. Although waste management is typically viewed as a function associated with later phases of the response and recovery, waste will start being generated immediately after an initial contaminating incident; therefore, pre-incident waste management planning is needed as well. It is not possible to pre-plan to a site-specific level, because the waste management approach will depend on the location-specific situation at the time of an incident. However, by considering waste management in advance, it becomes much easier to tailor a pre-incident waste management plan (WMP) to a specific site or biological incident rather than waiting to develop a plan after the incident occurs.

# 1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is designated as a coordinating agency under the National Response Framework (NRF) Emergency Support Function (ESF) 10 to prepare for, respond to, and recover from a threat to public health, welfare, or the environment caused by actual or potential oil and hazardous materials incidents (Department of Homeland Security (DHS); 2008a). Hazardous materials include chemical, biological, and radiological substances, whether accidentally or intentionally released. This document focuses on waste management of biocontaminated waste streams – not the releases themselves – except in some places where the best practices may vary depending on the progression of the release. Emergency response to these biological releases is governed by a number of Occupational Safety and Health Administration (OSHA) standards, including OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard (29 CFR 1910.120 or 29 CFR 1926.65). The 29 CFR 1910.120 standard applies to general industry and 29 CFR 1926.65 applies to the construction, respectively.

The NRF provides guidance for response and initial recovery functions immediately following an incident and consists of Incident Annexes that address the unique aspects of seven incident categories where specific roles involving waste management occur. Of particular interest for this document is the Biological Incident Annex that outlines biological incident response actions and procedures, and activities related to recovery. EPA's role for this type of incident is to support the determination of the extent of the contaminated area, sampling, and decontamination efforts (DHS, 2008b).

EPA is also designated as a support Agency for the U.S. Department of Agriculture's (USDA's) Animal and Plant Health Inspection Service (APHIS) activities in agricultural emergency response. Section 208 (a) of the Food Safety Modernization Act (FSMA) states that the EPA Administrator, in coordination with the U.S. Department of Health and Human Services (HHS), DHS, and USDA, shall provide support for, and technical assistance to, state, local, and tribal governments in preparing for, assessing, decontaminating, and recovering from an agriculture or food emergency. The NRF Food and Agriculture Incident Annex describes the roles and responsibilities associated with all incidents involving the nation's agriculture and food systems that require a coordinated federal response. EPA's role for this type of incident is focused on decontamination and disposal efforts (DHS, 2008c).

EPA's National Homeland Security Research Center (NHSRC) provides expertise and products that can be widely used to prevent, prepare for, and recover from public health and homeland security emergencies arising from terrorist threats and incidents. To support this effort, this document was prepared to provide best practices on the fate and transport of waste management operations after a biological agent incident, including best practices for handling waste after a biological incident. Initially, an extensive literature review was conducted of waste management topics related to types of biological and non-biological incidents such as natural disasters, operational exercises, medical waste handling during a disease outbreak, and the cleanup of sites contaminated by the intentional dissemination of a biological warfare agent. The review included the packaging and handling of biological waste, sampling and analysis for waste classification and identification, worker training, best practices for on-site waste treatment, waste disposal, personal protective equipment (PPE) selection and use, and information on biological agents of interest. The literature review was limited to previously published information from scholarly journals, the EPA, and other state and federal agencies, as well as unpublished, institutional knowledge the EPA has gained during responses to biological agent contamination. This document presents best practices for biocontaminated waste management that incorporates the results from the literature review, but is not a literature review in and of itself. These best practices also cite publicly available online guidance and handbooks that may be considered when responding to a biological agent incident.

## 1.1 Purpose of the Best Practices

The purpose of these best practices is to provide federal, state, territorial, and local waste management entities information on techniques and methodologies that have the potential to improve the handling and management of biocontaminated waste streams after a biological agent incident. These best practices are intended to be general in nature serving as a resource to a variety of biological agents in a variety of situations; however, these best practices also present a specific homeland security scenario – a biological attack with *Bacillus anthracis (B. anthracis)* – to help illustrate specific waste management considerations. A summary of the types of biological agents these best practices are intended to cover is discussed in Section 2.2.

> When available, this best practices document will provide specific examples to a ***B. anthracis*** attack. These specific examples will be designated by these graphic boxes.

For biological agent incidents (e.g., anthrax attack), it will be necessary to assess the extent of contamination and decontaminate victims, responders, animals, equipment, transportation conveyances, buildings, critical infrastructure, and large outdoor areas. Management of waste from a biological incident is complicated by having no overall federal-level regulations that specifically address all aspects of such waste. However, with or without an overall federal framework, states have the ability to establish more stringent requirements than federal requirements. Analysis of the processes involved in managing waste from biological contamination incidents has revealed that there are several potential routes of human exposure to biological agents (including, but not limited to, inhalation, ingestion, skin contact, and sharps). These exposures could happen during waste handling, treatment, sampling, packaging, transportation, and disposal operations and should be avoided and/or minimized in terms of worker safety and public health protection.

These best practices also discuss the importance of "pre-incident" waste management planning to potentially improve waste management preparedness. Although waste management is typically viewed as a function associated with later phases of the response and recovery, waste will start being generated immediately after an initial contaminating incident; therefore, pre-incident waste management planning is needed as well. It is not possible to pre-plan to a site-specific level, because the waste management approach will depend on the location-specific situation at the time of an incident. However, by considering waste management in advance, it becomes much easier to tailor a pre-incident waste management plan (WMP) to a specific site or biological incident rather than waiting to develop a plan after the incident occurs. Public communication should be considered when developing Pre-Incident WMPs.

## 1.2 Why These Best Practices are Necessary

Currently, very few Pre-Incident WMPs for biological agents exist; therefore, the best practices discussed in this document can provide valuable assistance (see Section 4 and Appendix A) in the development of new plans. Due to the infrequent nature of these types of incidents, there may be a lack of institutional knowledge of best practices on how to deal with the wastes generated from such incidents in a practical manner so that: 1) waste management activities do not adversely impact public health, worker safety, and the environment; and 2) the impact that waste management activities have on the remediation timeline is minimized so that affected areas and facilities can be safely brought back to re-occupancy and operation as quickly as possible.

During a biological incident with ***B. anthracis***, the causative agent of anthrax, the magnitude and complexity of the problem (indoors and outdoors, water and wastewater systems) and competing interests (regulatory, economic, public safety) will challenge existing operational frameworks. Preparing guidelines for response and recovery planning, specifically from a *B. anthracis* incident, will reduce the expenditure of time and resources required to recover a wide urban area following a biological incident, including meeting public health requirements and restoring critical infrastructure, key resources (both civilian and military), and high-traffic areas.

In a biological incident, federal, state, tribal, territorial, and local officials require a highly coordinated response to public health and medical emergencies. The incident may cross multiple jurisdictions, requiring the simultaneous management of multiple incident sites in coordination with multiple state, tribal, territorial, and local jurisdictions. These stakeholders may all play some type of role in preparing for, assessing, decontaminating, and recovering from a biological incident. The Geospatial Concept of Operations (GeoCONOPS) is an effort focused on supporting DHS and the emergency management activities that are required to support the NRF, ESF, and supporting federal partners. The GeoCONOPS is a community model that provides guidance on governance, policies, and processes as provided by Presidential Policy Directive 8 (PPD-8) and key stakeholders (i.e., state authorities, public law authorities, and their relationships). Figure 1 illustrates the GeoCONOPS Community Model that shows how the geospatial community interacts to accomplish the homeland security and emergency mission.

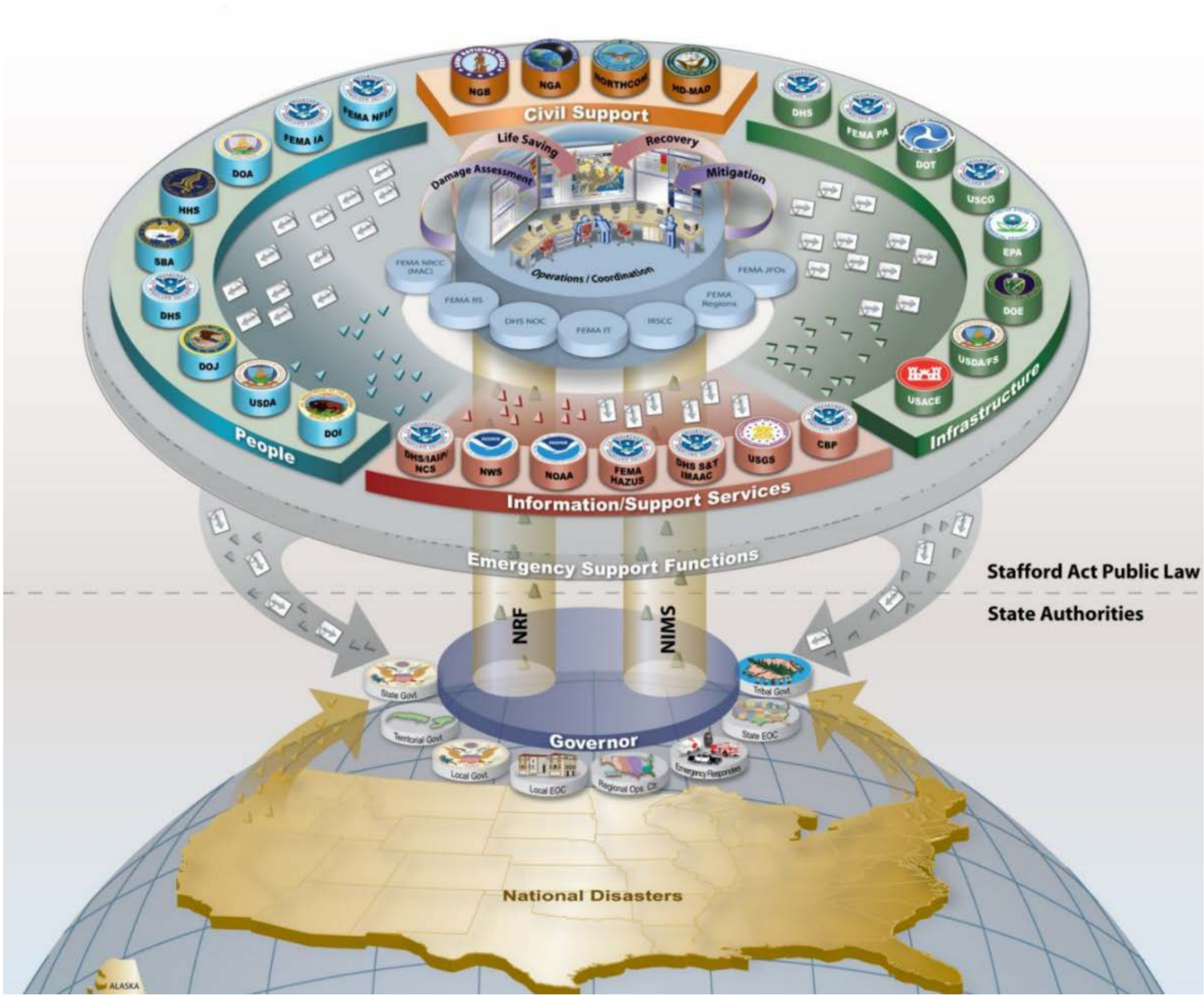



Figure 1. Geospatial Concept of Operations (GeoCONOPS) Community Model.

## 1.3 Approaches for Decontamination and How It Generates Waste

This document focuses on waste management of biocontaminated waste streams. To understand the various issues related to managing and handling materials that make up a waste stream, it is important to understand the approaches that can be taken to decontaminate the sites associated with biological agent releases/events that may occur. The waste streams discussed in this best practices document are a result of wide area and building decontamination methods described below. It should be emphasized that no single decontamination technology or strategy is effective for every situation. Decontaminating an area or item contaminated by a biological agent involves numerous issues specific to an individual location. Regulatory requirements will guide decontamination activities, likely coordinated by the EPA, with input from the CDC, under CERCLA regulations. Ultimate decisions will be those made at the scene by the Incident Command/Unified Command (IC/UC) (Raber et al., 2011).

Decontamination is a process that, when applied to contaminated materials, reduces the concentration of microorganisms or biotoxins of concern to a level considered safe by an appropriate regulatory authority. For a wide-area urban biological incident, the following seven categories of decontamination technologies may be considered for contaminated outdoor areas, indoor facilities and their contents, and water systems:

- Large-scale liquid distribution systems (such as firefighting or crop-dusting equipment) with selected reagents or surfactants to decontaminate and stabilize outdoor surfaces.
- Liquid or semi-liquid reagents to decontaminate exposed nonporous and porous surfaces, respectively, for indoor use as well as potential small-scale outdoor applications.
- Gaseous or vaporized reagents to decontaminate difficult-to-reach porous and nonporous indoor surfaces, including HVAC or air handling unit (AHU) systems.
- Technologies to decontaminate sensitive or expensive electronic equipment.
- Technologies to decontaminate small, personal, or valuable items such as certain artwork.
- Approaches to treat/decontaminate and minimize solid waste or wastewater.
- Approaches to decontaminate water resources and drinking water systems.

***Using B. anthracis as an example,*** select decontamination methods, their suitable usage conditions and phase of use during the decontamination process (source reduction or treatment/decontamination), and handling post-decontamination are outlined in Table 1. Once selected, decontamination processes are monitored as they are carried out, followed by evaluation to determine whether the desired level of contamination reduction has been achieved.

Methods to inactivate a biological agent include physical decontamination and chemical decontamination. Physical decontamination uses heat or radiation or removes the agent from the area or surface (rinsing with soap and water). Chemical decontamination involves the use of antimicrobial disinfectants or sterilants. Currently, liquid peroxyacetic acid with hydrogen peroxide (Peridox with the Electrostatic Decontamination System, EPA Registration Number 81073-2, Conditional), Steriplex Ultra™ (EPA Registration Number 84545-11), and DIKLOR G Chlorine Dioxide Sterilant Precursor (EPA Registration Number 73139-3) are the only chemical decontamination reagents registered by the EPA specifically for inactivation of *B. anthracis* spores. Therefore, for each specific use of any other selected chemical reagent to decontaminate a location contaminated by *B. anthracis* spores, a Federal Insecticide, Fungicide, Rodenticide Act (FIFRA) exemption may need to be obtained from EPA for site- and incident-specific use. In the past, the EPA approved eight chemicals for indoor use only against *B. anthracis* spores, each to be used by authorized personnel following the specific requirements of its crisis exemption:

- vaporous hydrogen peroxide (VHP),
- liquid and gaseous chlorine dioxide ($ClO_2$) created from sodium chlorite or sodium chlorate,
- liquid sodium hypochlorite (bleach, diluted 1:9 with water and neutralized with vinegar to pH 7),
- solid paraformaldehyde (heated to create formaldehyde gas),
- gaseous methyl bromide,
- liquid peroxyacetic acid with hydrogen peroxide,
- liquid hydrogen peroxide, and
- gaseous ethylene oxide (EtO).

Although the liquid chemicals potentially could be effective outdoors, the IC/UC must consult with the EPA about the need for obtaining approval for use of the unregistered antimicrobial chemical under a

FIFRA exemption for each specific site. Fumigants such as methyl bromide, which is injected as a pre-plant agricultural soil fumigant and contained with a plastic tarp, also could be considered for outdoor (soil) uses. Decontamination methods that work solely through physical means, such as heat, rinsing, cleaning, washing, or vacuuming, would not be subject to FIFRA and would not need a FIFRA exemption. Similarly, decontamination of biotoxins may not require a FIFRA exemption because biotoxins are not living organisms.

Liquid surface decontamination will generate decontamination waste that must be properly disposed of. Physical treatment with wet or dry vacuuming will produce contaminated collection waste in the capture vessel and/or filter that will require appropriate treatment and disposal. Treated surfaces should subsequently be decontaminated, generating additional waste. Some technologies may involve considerable post-decontamination cleaning of treated surfaces to neutralize the decontaminant and process any waste generated (New York City DOHMH, 2015).

In general, for all but the HVAC systems, decontamination by normal porous surface methods such as a thorough shampooing with a sporicidal agent of the carpets, seats, and other surfaces may be satisfactory. If possible, assessments of the HVAC system for contamination should be conducted. If the system is found to be contaminated, a portable fumigant generator, as well as other elementary fumigation techniques such as formaldehyde, might be effective.

Gross decontamination of highly contaminated areas can be used to pre-treat (e.g., HEPA vacuuming, surface decontamination) prior to the main decontamination event to improve the efficacy of the decontamination and minimize re-aerosolization. Treated waste cannot be considered to be uncontaminated solid waste unless waste sampling results verify that the established waste acceptance criteria (WAC) have been met. In general, on site (*in situ*) processes are preferable because they avoid the need to package and transport large quantities of contaminated waste to an on- or off-site waste management site or facility. In addition, if materials that enter the waste stream have been decontaminated *in situ* with the rest of the building, then waste handling might be able to be performed using lower levels of PPE. Off-site waste treatment requires identification of a treatment facility willing to accept the waste, the size of the load to be treated, the variety of waste streams, the need for waste segregation, pre-treatment requirements, and the type of packaging needed to contain the waste.

Deciding which decontamination method to apply at a given location requires in-depth evaluation of available methods, including the following factors:

- Availability and capacity of specific decontamination technologies;
- Emergency-response plans to address potential uncontrolled reagent release;
- Safety (e.g., toxicity, byproducts, persistence, and exposure limits);
- Efficacy (e.g., required contact times, penetration capability, efficacy data, and history of use);
- Generation, distribution, monitoring, and removal requirements;
- Cost (e.g., materials, equipment, and labor);
- Time (e.g., procurement, setup, testing, decontamination, removing equipment);
- Stakeholder concerns, including site- and incident-specific considerations;
- Waste generation; and
- Materials compatibility (DHS and EPA, 2009; Raber et al., 2011).

Site-specific environmental factors can play a significant role in the ability to achieve and maintain certain target decontamination application conditions (EPA, 2015). For example, low humidity, high temperatures, and wind can help dry materials during the application of liquid decontaminants but may also require increases in liquid volume applied, increasing the number of reapplications if the materials are to remain wet for certain target times. Similarly, achieving the appropriate temperature and humidity in cold or arid environments may be challenging for certain fumigants with such requirements. Fumigants used to decontaminate a building or other type of contaminated area may require containment for safety reasons as well as to reduce the quantity of gas needed to maintain the target conditions. Following fumigation, activated carbon units may be used as an air scrubber to vent the decontaminated area, depending on the fumigant used. In addition, HEPA filters may be used during aeration as a precaution to capture spores prior to clearance confirmation. If liquid chemicals are used for decontamination, surface runoff may require collection and treatment before disposal or release into the environment. The type and quantity of decontaminant and the method of disposal (such as release into a sanitary or storm sewer system, if acceptable to local authorities, or management as a hazardous waste) will determine the level of treatment required. Local water and sewer authorities should be contacted to determine the acceptability of plans to allow decontaminant runoff to enter natural waterways or discharge into sewer systems.

The type of decontamination method(s) employed will also impact the total quantity of liquid and solid waste generated. An EPA field-study was conducted to examine the effectiveness of three decontamination methods, separately, against *B. anthracis* spores in laboratory and/or field use (EPA, 2013). The methods tested were: 1) fumigation with hydrogen peroxide ($H_2O_2$), 2) a decontamination process incorporating the spraying of surfaces with pH-adjusted (or amended) bleach, and 3) fumigation with $ClO_2$ gas. For the particular scenario investigated in the field study (other scenarios may produce different results), results determined that the largest amount of solid waste was generated during the pH-adjusted bleach decontamination process in which porous surfaces were removed, bagged, decontaminated off site, and treated as waste (EPA, 2013). Waste generated during fumigation with VHP and $ClO_2$ only included items such as PPE and sampling waste (e.g., packaging) for both building decontamination and sampling. The largest amount of liquid waste was also generated during the pH-adjusted bleach decontamination process resulting from decontamination of the building. Decontamination liquid waste, comprised of the rinsate (a mixture diluted by water, solvents, oils, or rinsing agents or any other substances) recovered from the decontamination line, was also generated from all three methods during sampling.

## Table 1. Select Decontamination Technologies and Usage Conditions for *B. anthracis*-contaminated Waste.

| Decontamination Technology | | General Usage Conditions | | | | Phase for Use | | Post Decontamination Waste Handling Procedures |
|---|---|---|---|---|---|---|---|---|
| | | Porous | Nonporous | Sensitive Items | Off site Treatment | Source Reduction | Treatment | |
| Physical | HEPA Vacuuming | X | | | | X | X | Surfaces will require subsequent decontamination; contaminated HEPA filters must be safely disposed |
| Liquid | Sodium Hypochlorite solutions (bleach) | X | X | | | X | X | Item disposed as treated waste upon agent sampling verification<br>The bleach solution should be pH neutralized before disposal |
| | Hydrogen peroxide and Peroxyacetic Acid | | X | | | X | X | Item disposed as treated waste upon agent sampling verification |
| Fumigation | $ClO_2$ | X | X | | | | X | Item disposed as treated waste upon agent sampling verification<br><br>Area re-entry, as applicable, following agent sampling verification and demonstration of absence of fumigation residues. Residual gaseous material could be entrained in a wastewater stream and disposed of as liquid waste. Facilities must remain closed until both decontamination of the biological agent and the complete removal of the $ClO_2$ have been demonstrated. |
| | EtO | | | X | X | | X | Item disposed as treated waste upon agent sampling verification<br><br>Due to the explosive nature of EtO, these Systems are typically capable of treating small surface volumes (i.e., sensitive items that will allow reuse). Alternatively, the treated sensitive items could be reused; otherwise if the sensitive item is too large then paraformaldehyde, VHP, or $ClO_2$ can be used and the item should be disposed. |
| | Methyl bromide | X | X | X | | | X | Area re-entry, as applicable, following agent sampling verification and demonstration of absence of fumigation residues. |
| | Paraformaldehyde | X | X | X | | | X | Item disposed as treated waste upon agent sampling verification<br><br>Area re-entry, as applicable, following agent sampling verification and demonstration of absence of fumigation residues. Due to the suspected carcinogenic and toxic nature of paraformaldehyde, any building treated with paraformaldehyde must have formaldehyde gas neutralized with ammonium bicarbonate and be properly ventilated, or have a specially designed ventilation system. |
| | VHP | X | X | X | X | | X | Item disposed as treated waste upon agent sampling verification<br><br>Area re-entry, as applicable, following agent sampling verification and demonstration of absence of fumigation residues. |
| Steam and Pressure | Autoclave | X | X | | X | | X | Item disposed as treated waste upon agent sampling verification |
| Thermal | Incineration | X | X | | X | | X | Item disposed as treated waste upon agent sampling verification |
| Ionizing Irradiation | Irradiation | | | X | X | | X | Item disposed as treated waste upon agent sampling verification |

# 2. SCOPE OF THE BEST PRACTICES

This document aims to provide best practices for waste management activities, including waste handling, treatment, sampling, packaging, transportation, and disposal operations for waste that potentially contains biological agents, including information and proposed best practices for maximizing the efficiency of waste management operations while minimizing potential exposure of workers, as well as protecting public health and the environment. To set up a context for the situation under which this SOG might prove useful, a hypothetical biological contamination incident scenario will be presented in Section 2.3.

## 2.1 Intended Audience

The target audience for this SOG consists of those involved with the decision-making process for waste management activities prior to and during a biological incident response, including federal, state, and local emergency planners and managers who are tasked with developing Pre-Incident WMPs under the National Contingency Plan (NCP) and the National Planning Frameworks; the IC/UC; and the Technical Working Group (TWG) that may convene under the IC/UC. Other potential audiences might include members of the environmental group developing WMPs, the Planning Section Chief and Operations Section Chief in the IC response structure, workers who perform the waste handling and their employers, and waste treatment/disposal facilities that process the waste. More information about agency roles and responsibilities during a response can be found in Section 5.

## 2.2 Description of the Biological Agents of Interest

The main groups of biological agents of human interest are as follows:

- **Bacteria:** Most species are capable of reproducing outside living cells. Microscopic cells range in size from approximately 1 to 2 microns in diameter to approximately 2 to 10 microns in length (1,000 microns = 1 millimeter). Some bacterial diseases may respond to treatment with antibiotics. Vaccines are available for some bacterial diseases. Some species of bacteria such as *B. anthracis* are able to form endospores when unfavorable conditions are encountered (e.g., nutrient depletion). In this dormant spore state, these bacteria are more resistant to adverse condtions such as extreme heat or dryness than when in their non-dormant vegetative state. Once conditions are favorable, the spores can revert to their replicating vegetative state. When growing these types of bacteria in the laboratory, it is possible to induce them to form endospores under certain conditions.
- **Viruses:** Viruses cannot replicate outside living cells and require a living host to replicate. Viruses are typically much smaller in size than most bacteria (ranging from 0.02 to 0.2 microns). Viruses do respond to the correct antiviral treatment, but the correct one for a particular virus may not be known or tested. Vaccines are available for some viral diseases (e.g., measles).
- **Biological toxins (biotoxins):** Toxic substances produced by or extracted from bacteria, fungi, plants, or animals. Toxic substances can also be synthesized in the laboratory. Toxins do not replicate and are not contagious. Biotoxins are categorized into groups according to their molecular weight and composition or origin.

Biological agents are generally characterized by their infectivity/toxicity, lethality, severity of disease (virulence), mechanism of transmission, and stability. (Most bacterial and viral diseases are not contagious in humans, meaning they are are not transmissable directly from person to person (e.g., *B. anthracis*), whereas diseases caused by some agents can be transmitted (*Yersinia pestis*). Biological toxins are not contagious. These characteristics, among others (e.g., availability, ease of production) can contribute to interest in an agent for use in a deliberate biological attack.

The HHS and the USDA have published lists of microorganisms and biological toxins that are part of the Federal Select Agent Program regulated by the Centers for Disease Control and Prevention (CDC) and/or USDA's APHIS, depending on the agent category (refer to 7 CFR Part 331, 9 CFR Part 121, 42 CFR Part 73). The agents have been determined to have the potential to pose a severe threat to both human and animal health, to plant health, or to animal and plant products. Three categories have been defined regarding select agent and toxin identification: HHS select agents and toxins, Overlap select agents and toxins, and USDA select agents and toxins. Those classified as HHS agents have the potential to pose a severe threat to public health and safety. Overlap select agents and toxins have the potential to pose a severe threat to public health and safety and also to animal health or to animal products. USDA select agents and toxins have the potential to pose a severe threat to public health and safety, to animal or plant health, or to animal or plant products. A subset of the agents on the Select Agents and Toxins List are designated as "Tier 1" agents since they "*present the greatest risk of deliberate misuse with significant potential for mass casualties or devastating effect to the economy, critical infrastructure, or public confidence, and pose a severe threat to public health and safety*" (CDC, 2014). Key characteristics of the HHS and Overlap Tier 1 Select Agents and Toxins are outlined in Table 2.

Not all biological agents potentially encountered or found in environmental contamination are listed in the select agents list in Table 2; however, the best practices in this document may be applicable to them.

## 2.3 Description of the EPA Outlined Scenario

The agent used in the outlined scenario in this document is *B. anthracis*. The hypothetical biological incident scenario is consistent with National Planning Scenario 2 and was developed as part of the Wide Area Recovery & Resiliency Program (WARRP) in 2011 (DHS, 2012). This program worked with interagency partners (including federal/state/local/tribal governments), the military, private industry, and non-profit organizations to develop solutions to reduce the time and resources required to recover wide urban areas, military installations, and other critical infrastructure following a catastrophic Chemical, Biological, or Radiological (CBR) incident. The biological agent selected for the scenario was *B. anthracis*. The scenario, tailored for the urban Denver, Colorado area, consisted of a hypothetical covert attack by an organized worldwide terrorist group. The attack resulted in tens of thousands of people being exposed. A fraction of exposures resulted in deaths; a large number of exposures resulted in illness of varying levels of severity, thereby challenging medical facilities and personnel and requiring a significant amount of logistical coordination.

In general, an attack involving ***B. anthracis*** represents a difficult, long-term remediation problem because: 1) the agent is considered the most difficult of known potential biological agents to decontaminate, 2) *B. anthracis* spores remain viable for lengthy periods, and 3) dried spores are able to re-aerosolize in both indoor and outdoor environments (Raber et al., 2011).

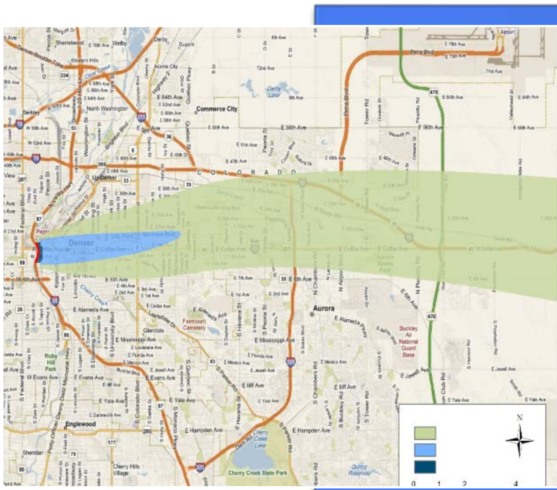
The areas significantly impacted by the contamination included critical infrastructure and commercial, military, and private property, covering over two areas of 10 square miles each and resulting in 500 contaminated buildings. The contamination caused local government operations to be relocated, and basic services, local businesses, and military installations were affected. A detailed description of the scenario is presented in Figure 2.

## Table 2. Characteristics for Tier 1 Select Agents.

| Agent[a] | | Disease | Type | Key Characteristics | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Incubation Period | Contagious? | Relative Stability / Persistence | Infectivity/Toxicity and or Lethality | Prophylaxis / Treatment |
| HHS Agents and Toxins | *Clostridium botulinum* neurotoxins | Botulism | Biotoxin | 6 hours to 10 within 12 to 36 days, oftenhours | No | Readily inactivated by sunlight and air; heating to 80 °C (176 °F) destroys botulism toxin; heating to more than 100 °C (212 °F) destroys *Clostridium botulinum* spores | Lethality 50 to 60% without treatment; 5 to 10% with treatment | None/Various antitoxins |
| | Ebola virus | Ebola | Virus | 2 to 21 days | Yes | Low | Case fatality rate is approximately 50% | In development/In development |
| | *Francisella tularensis* | Tularemia | Bacteria | 3 to 14 days | No | Less than one day if aerosolized; can persist for weeks in soil and water | Lethality approximately 1.4 %, higher for pneumonic form | None/Antibiotics |
| | Variola major virus | Smallpox | Virus | 7 to 17 days | Yes | Destroyed by sunlight and heat; virus dies within 24 hours if aerosolized; more persistent in colder temperatures | Lethality approximately 30% | Vaccine/None |
| | *Yersinia pestis* | Bubonic plague | Bacteria | Two to six days for bubonic; one to six days for pneumonic | Yes | Readily inactivated by sunlight; *Y. pestis* can survive in soil up to 3.5 months (more than 10 months in colder climates), in tap water up to 16 days, and in sterilized bottled water up to two years | High for pneumonic if untreated/lethality about 11% | None/Antibiotics |
| Overlap Agents | *Bacillus anthracis* | Anthrax | Bacteria | One to seven days; pneumonic cases have occurred 60 days after exposure | No | Spores highly persistent/stable; risk of secondary aerosolization | Moderate/high for inhalation exposure if not quickly diagnosed | Vaccine/Antibiotics |
| | *Burkholderia mallei / pseudomallei* | Glanders / Melioidosis | Bacteria | One day to four weeks for *B. mallei*; one to 21 days for *B. pseudomallei*, although may be months or years | Rare | *B. mallei* can survive in water up to 30 days; *B. pseudomallei* can survive in water over three years and in moist soil for up to two years | Animal infectivity high for both; human infectivity rare for B. mallei but common for B. pseudomallei/ lethality can be as high as 50% for both, even with treatment | None/Antibiotics |

[a] Marburg virus which has characteristics similar to Ebola virus and the milder form of smallpox virus,Variola minor virus (Alastrim), are also considered Tier 1 agents.
[b] Ebola (Ebola Virus Disease). Signs and Symptoms. Last accessed August 31, 2016: http://www.cdc.gov/vhf/ebola/symptoms/index.html

Source: Information derived from: (EPA, 2015), (CDC, 2014)



### WARRP Biological Attack Scenario

On an autumn Monday morning, a specialty fitted tractor trailer turns onto a busy street and enters the late rush hour traffic that is exiting downtown Denver. As the truck drives north, the driver's companion turns on a concealed improvised spraying device with a conventional nozzle that rapidly aerosolizes approximately 100 liters of wet fill B. anthracis (anthrax) slurry, 109 colony forming units per milliliter (cfu/mL). The dissemination efficiency achieved in the operation (1%) is comparatively modest. Nonetheless, it is sufficient to result in the potential exposure of 330,000 persons. Denver area BioWatch samplers detect the presence of anthrax. It is determined that the detected levels have triggered a BioWatch Actionable Results finding, and it is decided that a bioterrorism event has occurred. The appropriate notifications are made. Source: (EPA, 2012)

**Figure 2. WARRP Biological Attack Scenario Description.**

### *2.3.1 Determination of Extent of Contamination*

Based on this scenario, the types and number of structures impacted by the plume are summarized in Table 3. Using the information presented in the scenario, the quantity of the waste generated was estimated using EPA-developed tools and data designed to assist in the planning for wide-area remediation activities, including:

- Waste Estimation Support Tool (WEST) (building stock and outdoor areas)
- Incident Waste Decision Support Tool (I-WASTE DST) (building contents)
- Bioresponse Operational Testing and Evaluation (BOTE) Personnel Decontamination Waste Generation (EPA, 2013)

**Table 3: Type/Number of Structures Impacted by WARRP Biological Incident Scenario.**

| Structure | Total Number |
|---|---|
| **Fire Stations** | 4 |
| **Medical Facilities** | 8 |
| **Police Stations** | 11 |
| **Schools** | 78 |
| **Hazardous Materials Facilities** | 69 |
| **Residences** | 55,791 |
| **Everything Else** | 54,252 |

Source: (EPA, 2012)

Table 4 summarizes the calculated quantity of volumetric (liquid waste, expressed in gallons) and surface (solid waste, expressed in tons) waste generated by emergency personnel following decontamination based on the number of structures impacted by the scenario outlined in Table 3. Materials undergoing decontamination include structural (brick wood, reinforced concrete, steel, etc.) and interior (ceiling tiles, carpet, furniture, paper/office supplies, food, electronic equipment, etc.) contents.

**Table 4: Calculated Post-Decontamination Waste from WARRP Biological Scenario.**

| Waste Type | Post Decontamination Waste Quantity, Total (based on Number of Structures) | |
|---|---|---|
| | Volumetric | Surface |
| Liquid Waste from Personnel Decontamination During Sampling (gal) | 9,836,507 | 9,836,507 |
| Liquid Waste from Personnel Decontamination During Decontamination (gal) | 11,178,759 | 38,400,961 |
| **Total Liquid (gal)** | **21,015,266** | **48,237,467** |
| | | |
| Decontamination Waste from all interior materials (tons) | 11,389,009 | 33,545,017 |
| Solid Waste from Personnel Decontamination During Sampling (tons) | 13,367 | 13,367 |
| Solid Waste from Personnel Decontamination During Decontamination (tons) | 11,925 | 40,963 |
| **Total Solid (tons)** | **11,414,301** | **33,599,347** |

Source: (EPA, 2012)

## 2.4 Phases of Response and Recovery Efforts

When responding to a biological incident, effective and timely decision-making requires an understanding of many aspects of response and recovery. The main phases and activities in preparing for and responding to a biological incident are summarized in Table 5.

The preparation phase should commence prior to a biological incident. This phase should involve planning, organizing, training, conducting exercises, evaluating, and improving procedures. The respond and recover phases then commence, following an incident and encompasses two major parts: 1) crisis management, and 2) consequence management. The primary activities in crisis management involve notification and first response; however, because these best practices focus on waste management activities that are primarily conducted in the consequence management phase, activities part of crisis management will not be discussed further in this document. The consequence management phase begins with characterization activities, which entail strategies to characterize the agent and the affected site(s) and to examine the relative persistence and spread of the agent. This information is used to assess the potential health and environmental consequences. As part of consequence management, remediation activities then follow, focusing on implementation of plans to decontaminate the contaminated site and its contents. Waste handling and waste management operations are implemented in this phase. During the clearance stage, environmental sampling and analysis procedures are performed to determine the effectiveness of the decontamination. The final clearance decision is made by the IC/UC and/or responsible local/state agencies (e.g., public health). The consequence management phase ends with restoration, which focuses on preparing an area or facility for re-occupancy, reuse, or refurbishment. Prior to opening a site to the general public, decontamination must be deemed successful (i.e., no significant risk exists). Additionally, longer-term environmental health monitoring may be required to ensure that the re-occupancy and reuse criteria are met.

## Table 5: Key Preparation, Response, and Recovery Decisions.

| Preparation Phase | Response and Recovery Phases | | | | | |
|---|---|---|---|---|---|---|
| | Crisis Management | | Consequence Management | | | |
| **Prepare** | **Notification** | **First Response** | **Characterization** | **Remediation** | **Clearance** | **Restoration** |
| Pre-Incident WMP<br>Incident-Specific WMP<br>Organize, train, and equip<br>Exercise<br>Evaluate and improve<br>Develop SOG documents | Initiate first response activities, including notification of proper authorities<br>Develop a public-engagement campaign<br>Evaluate Threat Credibility | Operational Coordination Law enforcement, intelligence, and investigative response<br>When and how to distribute medical countermeasures<br>Recommend staying-in-place or evacuation<br>Recommend quarantine/ isolation/social distancing<br>Implement transportation restrictions<br>Provide safety and health guidance and protections to impacted first responders and citizens<br>Issue guidance on personal hygiene or decontamination<br>Provide support for mass casualty<br>Establish mass medical treatment facilities<br>Implement modified standards of care | Develop/implement strategies for characterization in facilities and the outdoors<br>Implement strategies and procedures to identify, stabilize, and maintain infrastructure and property<br>Determine requirements and methods to protect natural and cultural resources<br>Implement strategies and means to contain and mitigate the spread of contamination and eliminate sources of further distribution | Decontaminate outdoor areas and/or buildings<br>Decontaminate wide areas<br>Implement required capabilities for sustained environmental decontamination operations<br>Implement decontamination waste handling requirements<br>Worker health and safety<br>Decontaminate critical infrastructure<br>Waste management | Provide guidance for determination of effectiveness of decontamination | Provide guidance for re-occupancy and reuse criteria and goals<br>Provide guidance for controls to implement, reduce, mitigate any potential exposures or future incidents after re-occupancy<br>Implement public messaging to instill confidence in the public and workforce that re-occupancy is safe<br>Implement measures to retain, maintain and improve the economic vitality of a region<br>Implement long term health treatment, intervention and surveillance strategy |

Source: Adapted from National Science and Technology Council (NSTC) Roadmap, 2013

# 3. STATE AND FEDERAL BIOAGENT WASTE HANDLING PROCEDURES

Previous incidents that have occurred in the United States and generated large amounts of hazardous waste requiring treatment and disposal can serve as case studies for identifying issues and solutions for handling and managing biological agent-contaminated waste. This information is important for timely and efficient planning and response to incidents.

As stressed in earlier sections, pre-incident waste management planning is needed. It is not possible to pre-plan to a site-specific level, because the waste management approach will depend on the location-specific situation at the time of an incident. This has also been a common occurrence in large incidents involving biological/infectious agents (described below), or even manmade incidents such as the Deepwater Horizon Oil Spill. It is not enough to have a plan; the plan should be exercised and trained against to determine the success of the plan. Lessons learned from the exercises and training should be captured and incorporated back into the plans to maintain constant improvement. There are multiple examples (e.g., Amerithrax, Ebola Virus, Hurricane Sandy, Deepwater Horizon, Fukushima, etc.) where existing debris/WMPs were not robust enough to address the incident. This is one of the reasons that DHS has encouraged federal, state and local emergency planners and managers to utilize the National Planning Scenarios in their planning. These scenarios require robust planning by having wide area incidents that drive the need for thorough and well thought out plans.

A brief summary of the events and cursory review of lessons learned from several historical biological incidents in the United States are discussed in the following sub-sections. The incidents reviewed represent multiple classes of biological agents, including a spore-forming bacterium, two viruses, and a biotoxin, as well as general waste debris.

- Amerithrax (2001); *B. anthracis* sent through the mail, contaminating mail facilities, media buildings, and U.S. Senate facilities;
- Ricin biotoxin (2004); Ricin powder found in the Dirksen Senate Office Building in Washington, D.C;
- Hurricane Katrina (2005); A Category 5 hurricane made landfall in New Orleans, Louisiana, as a Category 4 hurricane, resulting in widespread devastation;
- Ebola Virus (2014); An outbreak of Ebola virus in West Africa resulted in several cases in the United States;
- Highly Pathogenic Avian Influenza (HPAI) (2015); A multi-state outbreak of HPAI resulted in many contaminated premises and millions of dead birds requiring disposal.

The lessons learned in these case studies are often broader than waste management issues; however, by understanding all issues from a biological incident response, planners and responders may develop a greater understanding of how to apply specific waste management best practices in a variety of situations. From all of these incidents, a common lesson learned is that response planning should focus on the Pre-Incident WMP first; by considering waste management in advance, it becomes much easier to tailor a pre-incident WMP to a specific site or biological incident, which could prevent problems before an actual incident occurs. Many of the lessons learned in these incidents occurred during the incident and proved costly and difficult to implement.

## 3.1 Amerithrax Lessons Learned

Three incidents of *B. anthracis* occurred in the United States in September of 2001. In the first release, letters containing anthrax spores were mailed from New Jersey to media offices in New York City; the letters passed through the Hamilton Processing and Distribution Center (P&DC) in Trenton, New Jersey, on September 18. The second release involved a letter sent in late September to American Media Incorporated in Boca Raton, Florida. In the third release, letters addressed to Senators Tom Daschle and Patrick Leahy in the Hart Senate Office Building entered the Hamilton P&DC on October 9. Numerous sites, including the Hart Senate Office Building, postal facilities, media offices, and residences, were contaminated directly or through secondary contamination. The contaminated postal facilities included physically large P&DCs such as the Hamilton P&DC and the Morgan P&DC in New York City (which processes all mail into and out of Manhattan), and the Curseen-Morris facility (which handles all mail to and from the federal government in the D.C. metropolitan area). Numerous smaller postal facilities also were contaminated, as were a number of federal government mail facilities downstream of the Curseen-Morris facility (Simpson 2005). Overall, approximately 3,250 bags of critical items and 4,000 packages and drums of additional mail were sent for treatment (Government Accountability Office (GAO); 2003). The Capitol Hill anthrax cleanup site included 26 buildings; samples from seven of the 26 buildings tested positive for *B. anthracis*, which subsequently required further sampling followed by decontamination (GAO, 2003).

Summary observations, recommendations and/or information gaps stemming from the incident response, as identified from a cursory review of the literature, are captured below.

- Governmental entities should develop more extensive plans and procedures to maximize involvement of all stakeholders; conduct further training and drills, especially for sampling, analysis, and coordination procedures (Simpson, 2005).
- Determine the appropriate number, size, and locations of chlorine dioxide generators (Simpson, 2005).
- Following a wide-area attack, no materials, other than items that are essential or of high value or may consume the decontamination reagent, should be removed from contaminated facilities before decontamination because costs would otherwise be prohibitive: space and waste management options are expected to be limited, and time is of the essence (Raber et al., 2011).
- A waste management plan should be developed at the same time as decontamination planning, if not before. The waste management plan should reflect any state, local, or facility requirements (e.g., decontamination actions, post-decontamination sampling, and PPE for transportation and disposal facility workers) for the management of decontaminated material as municipal waste (Raber et al., 2011).
- State authorities have the primary responsibility to regulate and oversee management of wastes that may be contaminated with an infectious agent such as *B. anthracis*. It is highly advisable to establish contact in advance of an incident or early in the remediation process with waste management stakeholders such as publicly-owned wastewater treatment operators and landfill, incinerator, and sterilization facilities (Raber et al. 2011).
- Determining ownership of items in a contaminated facility, such as valuable documents, remains an issue. Owners and managers of these facilities should create and maintain ownership records of valuable and important items; they should have detailed and current floor plans and information about air flow patterns, under routine and non-routine conditions (Simpson, 2005).

- To date, EPA has concluded that chlorine dioxide gas shows the most promise for remediating contaminated facilities (Simpson, 2005); however, other solutions have been identified and are available.

## 3.2 Ricin Lessons Learned

Ricin is a biotoxin that can be extracted from castor beans relatively easily; many open-source literature protocols exist for ricin isolation, and castor beans are readily accessible. Human exposure to ricin can occur through several routes, including inhalation, ingestion, absorption, and injection. The most lethal route of exposure is through injection, but exposure to ricin powder by other routes poses the most serious public health and medical threat (HHS, 2006). Exposure to ricin in high doses can cause organ failure and death, with initial symptoms developing within 4 to 8 hours of inhalation and within up to 10 hours for ingestion. In February 2004, white powder found in the Dirksen Senate Office Building in Washington, D.C., tested positive for ricin and ricin white powder (HHS, 2006). Worldwide, incidents involving criminal usage of ricin have occurred or are uncovered by law enforcement on an annual basis since the late 1990s.

There are a number of OSHA standards that may apply to exposure to ricin, including the HAZWOPER standard (29 CFR 1910.120 or 29 CFR 1926.65) during an environmental release or substantial threat of a release, as well as the PPE standards (29 CFR 1910 Subpart I) in some exposure scenarios. Since airborne particles may pose the greatest threat to personnel, respiratory protection is a necessary component of the PPE program. Cleanup workers in situations requiring respiratory protection are protected under the OSHA Respiratory Protection Standard (29 CFR 1910.134), which requires medical clearance, fit testing, training, and other elements of a respiratory protection program beyond just provision of respirators.

Summary observations, recommendations, and/or information gaps stemming from the incident response, as identified from a cursory review of the literature, are captured below (HHS, 2006).

- It is important that first responders work in conjunction with law enforcement officials, as collected samples of ricin may become evidence in a criminal prosecution. Law enforcement officials need to be consulted before beginning decontamination activities to determine whether additional evidence may exist at the crime scene.
- A high efficiency particulate vacuum may be used to reduce surface contaminant levels, the spread of particulates, and the potential for re-aerosolization.
- Heating, ventilation, and air conditioning (HVAC) ducts serving the affected area may also need to be sealed. The ducts can be sealed within the affected room or at external locations as long as the selected decontamination technology effectively decontaminates the ductwork between the room and the external seal. An HVAC specialist should be consulted.
- No decontamination wastewater should be discharged until the water is treated in accordance with appropriate guidelines and until agreements have been reached with, and approved by, the local utility manager, publicly owned treatment works operator, public health officials, and/or other affected parties.
- With regard to sample packaging, guidelines should be followed to preserve the integrity of the sample (i.e., prevent leakage), to clearly document what form the sample is in and where it was collected, and to withstand possible rough handling during transport.
- The primary means of disposal for ricin-containing waste is through high-temperature thermal incineration or through landfilling in a lined landfill. It is important to contact potential waste

disposal facilities early on in the response, so that appropriate arrangements can be made and potential regulatory and technical obstacles can be identified.

- Standards for re-occupancy of a building after a ricin event need to be developed.

## 3.3 Hurricane Katrina Lessons Learned

On August 23, 2005, Hurricane Katrina formed as a tropical storm off the coast of the Bahamas. Over the next seven days, the tropical storm grew into a catastrophic (i.e., category 3) hurricane that made landfall first in Florida and then along the Gulf Coast in Mississippi, Louisiana, and Alabama, leaving a trail of devastation and human suffering. Katrina wrought staggering physical destruction along its path, flooded the historic city of New Orleans, ultimately killed over 1,300 people, and became the most destructive natural disaster in American history (United States. Executive Office of the President and Assistant to the President for Homeland Security and Counterterrorism, 2006).

Hurricane Katrina and the subsequent sustained flooding of New Orleans exposed significant flaws in federal, state, and local preparedness for catastrophic events and the nation's capacity to respond to them. Emergency plans at all levels of government were put to the test.

Overall, the major lesson learned, for the purpose of this document, was that there was no debris management plan in place. As a result, the approach has changed in that DHS and the Federal Emergency Management Agency (FEMA) have been encouraging an “all hazards” approach to planning.

Summary observations, recommendations, and/or information gaps stemming from the incident response, as identified from a cursory review of the literature, are captured below.

- Federal response should better integrate the contributions of volunteers and non-governmental organizations (NGOs) into the broader national effort. This integration would be best achieved at the state and local levels, prior to future incidents. In particular, state and local governments must engage NGOs in the planning process, credential their personnel, and provide them the necessary resource support for their involvement in a joint response (United States. Executive Office of the President and Assistant to the President for Homeland Security and Counterterrorism, 2006).
- Physical work (e.g., removal of debris) generally is done by contractors, to the extent that it cannot be accomplished by local government sanitation workers. FEMA reimbursed local governments for debris removal on public and private property in counties that applied for assistance (Esworthy et al., 2005).
- Adequate storage capacity was not available; EPA provided guidance that states State Directors (meaning the chief administrative officer of the lead state agency) have the authority to establish staging/storage areas that would be considered Part 257 facilities under federal rules (EPA, 2012).
- EPA provided guidance stating that State Directors have the authority to reopen closed construction and debris (C&D), and municipal solid waste (MSW) landfills for the disposal of disaster debris (EPA, 2012).
- EPA provided guidance stating that open burning is an allowable option under federal rules for debris resulting from emergency clean-up operations (EPA, 2012).
- Prevention efforts (e.g., booms, skimmers, aerators) undertaken by the U.S. Army Corps of Engineers (USACE) were reported to have had little effect on limiting any toxic chemicals, metals, or pesticides in the discharged water (Esworthy et al., 2005).

- EPA worked with states and USACE to develop guidance for the handling of polychlorinated biphenyls (PCBs) and asbestos-containing materials (ACM) (EPA, 2012).

## 3.4 Ebola Virus Lessons Learned

Ebola virus disease (EVD) is a recently recognized illness. Early recognition and treatment is critical to controlling the spread and case-fatality rate. EVD first appeared in 1976 in two simultaneous outbreaks: one in what is now Nzara, South Sudan, and the other in Yambuku, Democratic Republic of Congo. The latter occurred in a village near the Ebola River, from which the disease takes its name. The 2014 Ebola Outbreak was the largest recorded and the first in West Africa. The virus can be transmitted to people from wild animals and spreads in the human population through human-to-human transmission. The average EVD case fatality rate is approximately 50% (World Health Organization (WHO); 2015).

The CDC and partners took many precautions to prevent the spread of Ebola within the United States, and CDC has since developed guidance for healthcare workers (hospital, laboratory, emergency medical response, mortuary and funeral, and air medical transport) and non-healthcare workers (airline workers, wastewater workers, humanitarian aid workers, decontamination, cleaning, and waste removal workers).[1]

Summary observations, recommendations, and/or information gaps stemming from the incident response, as identified from a cursory review of the literature, are captured below.

- Create a WMP and secure necessary contracts and permits in advance to help avoid potential exposure hazards, security risks, and storage problems. Pre-identify waste management facilities prior to waste generation; waste management facilities may have their own requirements that may need to be considered (OSHA, 2016).
- Do not use waste management processes that involve shredding incoming waste materials that have suspected or confirmed Ebola virus contamination (OSHA, 2016).
- Place contaminated materials in double leak-proof bags and store in a rigid, leak-proof container to reduce the risk of worker exposure. If waste ultimately will be transported, follow U.S. Department of Transportation (DOT) guidance for packaging from the outset to minimize repackaging or additional handling (OSHA, 2016).
- Ebola-associated waste may be incinerated. The products of incineration (i.e., the ash) can be transported and disposed of in accordance with state and local regulations and standard protocols for hospital waste disposal (OSHA, 2016). Ebola-associated waste disposal is subject to state and local regulations. Ebola-associated waste that has been appropriately inactivated or incinerated is not infectious and is not considered to be regulated medical waste or a hazardous material under federal law (CDC, 2015).
- Community engagement is key to successfully controlling outbreaks (WHO, 2015).

## 3.5 Highly Pathogenic Avian Influenza Lessons Learned

Occurrence of HPAI in the United States has been very infrequent, has been contained, and normally affects only birds. The Asian HPAI form, which is a subtype of HPAI, also known as H5N1, has been found in Asia, Europe, and Africa, but not in the United States to date. H5N1 spreads very rapidly through poultry flocks, causing mortality rates of domesticated birds that can approach 100% within 48 hours. Hundreds of millions of domesticated birds have been killed by the virus or culled to prevent further spread of disease. There have been some cases in Asia and Eastern Europe of HPAI H5N1 spreading to

[1] The latest CDC guidance for healthcare workers can be found online: http://www.cdc.gov/vhf/ebola/ (Accessed July 18, 2016).

humans through sustained close contact with live birds. The USDA has indicated that this virus has the potential to generate large numbers of animal carcasses from the response to an avian influenza outbreak (U.S. Environmental Protection Agency (EPA, 2006). In January 2015, an outbreak of avian influenza subtype H5N2 was identified in a series of chicken and turkey farming operations in the midwestern region of the United States. With the last case of the spring outbreak identified in June, 2015, a total of 211 commercial and 21 backyard poultry premises had been affected, resulting in the depopulation of 7.5 million turkeys and 42.1 million egg-layer and pullet chickens (APHIS, 2016). As a direct result of this outbreak, the USDA published a plan in January 2016 for preventing and responding to future HPAI cases, in collaboration with industry and state partners (APHIS, 2016).

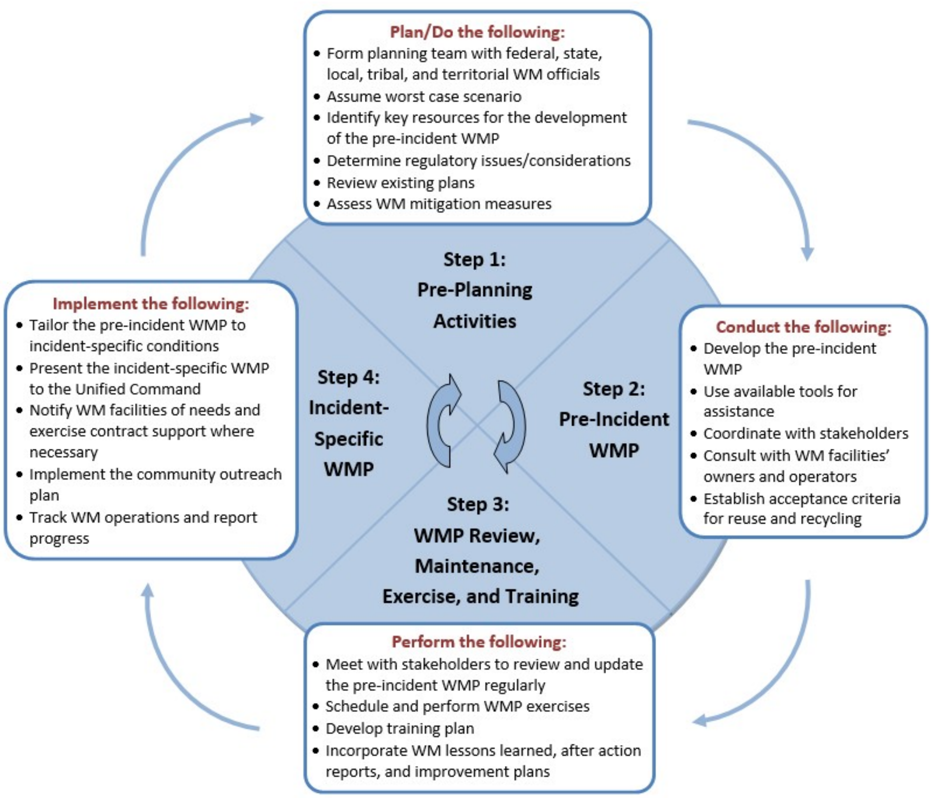
Summary observations, recommendations, and/or information gaps stemming from the incident response, as identified from a cursory review of the literature, are captured below.

- State and local stakeholders should put in place an emergency management plan through the formation of an ad hoc team of experts (Beato et al., 2009).
- Infected animals should be rounded up quickly, euthanized humanely, and disposed of. It is not recommended to store sick animals or carcasses for any length of time (Beato et al., 2009).
- Carcasses that will be transported must be contained in sturdy plastic bags. The inside of transport vehicles may be lined with plastic as well in an effort to double-contain transported carcasses. Bird carcasses may be composted, rendered, or incinerated (Beato et al., 2009).
- Trucks used for transport must be decontaminated using carwash-style practices with an appropriate disinfectant followed by soap and water. The inside of the vehicle should be cleaned using appropriate disinfectant. Emphasis should be placed on cleaning the undercarriage of the vehicle (Beato et al., 2009).
- When selecting a location for composting, burial, or landfill, it is essential to plan away from groundwater sources (Beato et al., 2009).
- Groundwater sources close to burial, landfill, and composting sites should be monitored closely in the years following the outbreak. High levels of nitrogen, total dissolved solids, and chloride have been observed (Beato et al., 2009).
- Composting is the preferred on-site treatment method. The compost pile must reach a minimum of 130 °F, set for 11 to 14 days, turned inside out, and returned to 130 °F for at least two days. After 28 days, the composted material can be released for off-site land application, stockpiling, or incineration with approval from the IC (Minnesota Board of Animal Health, 2015).
- Factors important for successful in-house composting are the involvement of poultry companies in managing the process, the formation of an expert team, the availability of carbon material and letter, and the identification of response teams that are trained and equipped to compost flocks within 24 hours of virus confirmation. In-house composting is the preferred method of disposal in the United States (Beato et al., 2009).
- For the H5N2 outbreak, there were a number of pre-incident plans in place; however, responders tended to focus on the emergency tasks at hand rather than refer to the plans to address the size of the H5N2 outbreak and the magnitude of waste management activities associated with it. In addition, there were too few responders with waste management expertise, and just-in-time training is not possible for the level of complexity associated with waste management tasks.

# 4. PLANNING ASSUMPTIONS

To facilitate management of waste generated from a homeland security incident, the EPA (2016b) recommends that communities have a Pre-Incident WMP. The primary goal of pre-incident waste management planning is to prepare a community to effectively manage waste, debris, and materials, especially in larger quantities, which may include wastes, such as chemical, biological, and radiological-contaminated wastes not typically handled. An all-hazards pre-incident waste management planning process depicted in Figure 3 is a four-step process designed to help communities prepare for waste management needs of an incident, regardless of the hazard.

This recommended process guides emergency managers and planners through four main steps that cover the initiation, creation, updating, and implementation of a WMP. The waste management planning process does not have to be completed at one time or by one person for a community. Pre-Incident WMP guidelines developed by EPA's Office of Resource Conservation and Recovery (ORCR) are described in Appendix A; a plan template outline is provided in Table A-1.




Source: (EPA, 2016b)

**Figure 3. Pre-incident All-Hazards Waste Management Planning Process.**

## 4.1 Pre-Incident Management Planning

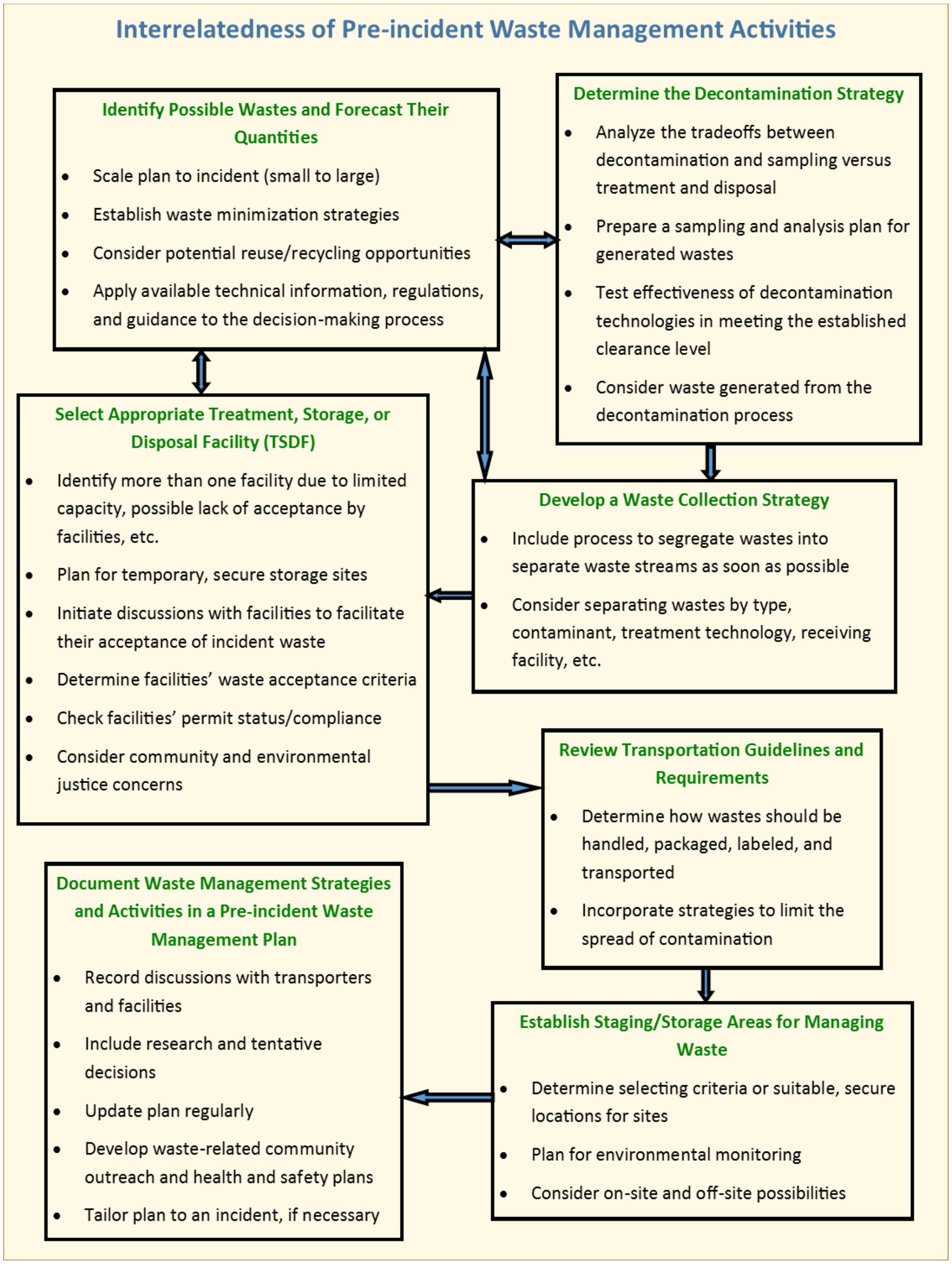
Pre-incident planning identifies applicable regulations, possible options for managing the anticipated waste, and waste acceptance criteria (WAC) for facilities. Pre-incident planning should be documented in a Pre-Incident WMP. When an incident occurs, the Pre-Incident WMP can be tailored to the actual incident, facilitating the waste management decision-making process during the incident. This plan should record discussions with transporters and facilities for waste treatment/disposal; include research and tentative decisions regarding treatment and handling; consider health and safety requirements; and develop waste management related community outreach. Specific factors to be considered when developing Pre-Incident WMPs includes the following (depicted in Figure 4):

- Possible wastes and quantities;
- Decontamination strategy;
- Waste collection strategy;
- Appropriate treatment, storage, or disposal facilities;
- Transportation guidelines and requirements; and
- Staging/storage areas for managing waste.

As part of this plan, non-specific scenario information for critical infrastructure assets and characteristics should be acquired, including a written record of information such as:

- Asset names and locations;
- Critical services provided by the asset;
- Dependencies between services and between assets;
- Workaround capabilities for services provided by each asset; and
- Milestone requirements for services and assets.

Additionally, restoration objectives and priorities should be considered and negotiated by emergency planners, infrastructure owners, and other private and public stakeholders in neighboring jurisdictions (New York City DOHMH, 2015).




Source: (EPA, 2016b)

**Figure 4. Pre-Incident Waste Management Planning Considerations.**

### *4.1.1 Available Management Tools*

Table 6 provides examples of software management tools that may be useful for pre-incident planning for a biological incident, including tools to address a *B. anthracis* attack. The contact information identified for each tool may change over time and may require reaching back to the software developers. Some tools are directly related to waste management like I-WASTE DST, while other tools like the mapping and spatial software are indirectly related to waste management that could be utilized for pre-incident planning purposes.

### Table 6. Example Software Management Tools Available for Pre-Incident Planning.

| Management Software Tool | Function | Developer/Contact Information |
|---|---|---|
| Prioritization Analysis Tool for All-Hazards/Analyzer for Wide Area Restoration Effectiveness (PATH/AWARE) | Quantitative methodology for infrastructure prioritization process and generation of restoration timelines (biological incidents) | Sandia National Laboratories [(a)] http://prod.sandia.gov/techlib/access-control.cgi/2012/129466.pdf) Accessed July 13, 2016. |
| FASTMap | Provides detailed GIS-based and statistical data on important economic sectors as well as the location of critical infrastructure and economic assets at risk | Sandia National Laboratories [(b)] http://www.sandia.gov/nisac/analyses/fast-analysis-and-simulation-team-fast/fastmap/ Accessed July 13, 2016. |
| Decontamination Strategy and Technology Selection Tool (DeconST) | Supports decision-making for the selection of decontamination options for individual specific buildings contaminated with *B. anthracis* spores (expandable to address other biological agents). Includes WM and WM costs in the analysis of decontamination options in facilitating the development of facility-specific, remediation approaches. | Sandia National Laboratories |
| Incident Waste Decision Support Tool (I-WASTE DST) | Decision support tool that organizes large amounts of information related to managing waste resulting from incidents of national significance (e.g., contaminated buildings and natural disasters) | EPA NHSRC http://www2.ergweb.com/bdrtool/login.asp Accessed July 13, 2016. |
| Building Restoration Operations Optimization Model (BROOM) | Indoor and outdoor data acquisition, data management, and data analysis | Sandia National Laboratories http://www.trb.org/Main/Blurbs/155841.aspx Accessed July 13, 2016. |
| Visual Sample Plan (VSP) | Statistical software program that estimates sample sizes for given probabilities of detection using estimated population variability (compatible with BROOM) | Pacific Northwest National Laboratory (PNNL–Battelle) http://vsp.pnnl.gov/ Accessed July 13, 2016. |
| Spatial Analysis and Decision Assistance (SADA) | Statistical software program focuses on cost–benefit analysis and sampling location | University of Tennessee and Oak Ridge National Laboratory (ORNL) http://www.sadaproject.net/ Accessed July 13, 2016. |
| Fully Integrated Environmental Location Decision Support (FIELDS) | Combines GIS, Global Positioning System (GPS), database, analysis, and imaging technologies to assist in environmental cleanup efforts. Also available is F/S Plus (combination of FIELDS and SADA) | EPA https://www.epa.gov/superfund Accessed July 13, 2016. |

## 4.2 Nature and Consequences of a Biological Incident

A biological incident involves the natural, accidental, or intentional release of a pathogen or biological toxin that affects humans, plants, or animals. The scenario described in this document is focused on a deliberate attack against humans aimed to cause illness, death, fear, societal disruption, and economic damage. Unlike a chemical or nuclear incident, a biological incident may go undetected for hours, days, or weeks depending on the agent used and the scenario employed, until humans or animals begin to exhibit symptoms of disease. If there are no obvious or immediate signs of a biological incident, first detection may be made by a local health care worker observing a pattern of atypical illnesses or by early warning monitoring systems that detect airborne pathogens. For an aerosol release, the area impacted would depend on the quantity of agent released, where the agent was released (indoors or outdoors), and weather conditions. The persistence of the agent may be negatively impacted by the method of dissemination as well as environmental conditions (e.g., sunlight, precipitation events, and relative humidity) which can degrade, inhibit the spread, or otherwise inactivate the agent. Dispersion of a biological agent released outdoors would generally occur in the direction of the prevailing wind, while the spread of agents released indoors would be profoundly impacted by the building's air-handling systems. Water and wastewater systems may also spread the agent vast distances while maintaining high concentrations. Following deposition, the agent would be subject to relocation and human activity (vehicle and pedestrian traffic) potentially causing secondary human exposures, which would continue to pose a hazard throughout the entire response and recovery process. Re-aerosolization by weather (wind and rain) only poses a hazard until decontamination is complete, not necessarily throughout the entire recovery process.

The relative environmental stability of an agent can also impact its waste management. Some agents die or inactivate rapidly when not in a suitable environment or a host, while others are adapted for existing long term in the environment; it is even possible to formulate agents to increase their stability in the environment. Heat, humidity, dryness, and ultraviolet radiation are all known to kill many microorganisms in the environment. However, susceptibility to such factors varies by agent; for example, *B. anthracis* spores can be less susceptible to these conditions than other agents. The environmental persistence of a particular agent is an important factor in selecting the type and extent of remediation activities. Agents that persist in some environments for only minutes or hours may require only minimal intervention for decontamination.

## 4.3 Bioagent Waste Characterization

In general, the contaminated waste streams from a biological incident are likely to be highly variable, ranging from building debris and contents (possibly as the result of demolition activities [e.g., concrete rubble, structural metal, asbestos-containing materials, carpets, wallboard, electronics, etc.]) to contaminated liquids (e.g., decontamination waste water) and sludge. Under DOT Hazardous Materials Regulations (HMRs), 40 CFR 262, the generator of waste is required to determine whether the waste is hazardous. For wastes not listed in this rule, waste generators may do this either by testing the waste according to specified methods or through process knowledge.

> Because biological threat agents are not identified as part of the federal hazardous waste regulatory framework, it is very important that waste characterization and identification requirements are consistent with state and local requirements, as well the WAC of potential waste management facilities identified in waste management planning.

As previously discussed, Pre-Incident planning will greatly expedite the response and recovery timeframe and thus reduce overall costs. Waste streams should be sampled and characterized early in the remediation process to determine whether the surface of an article is contaminated prior to handling, packaging, and transporting the article off-site (New York City DOHMH, 2015). It is possible for characterization sampling efforts that are performed to cover the needed waste characterization requirements also, thus saving sampling time and analysis costs and helping to avoid overburdening laboratories performing analyses.

## 4.4 Estimated Types and Quantities of Waste

Waste streams from a wide-area biological incident would originate from all phases of remediation and would include contaminated indoor and outdoor materials, waste generated from personnel and equipment decontamination, and waste generated from packaging and transporting contaminated materials. The total could amount to hundreds of thousands or millions of tons and millions of gallons in a large urban area. For example, the three major categories of biocontaminated wastes expected from remediation are:

1. PPE and other materials associated with sampling and decontamination;
2. Materials discarded due to either damage caused during decontamination or technical difficulties associated with proving that they have been effectively decontaminated; these materials may or may not have residual contamination prior to handling as waste; and
3. Wastewater generated during decontamination, runoff from precipitation, and runoff from possible flushing of water distribution systems.

It is highly likely that waste generated from a biological incident would be able to be separated based on composition and item type (i.e., biological incidents will not likely generate large quantities of commingled (mixed/blended) debris); therefore an effective segregation strategy can be very useful.

The quantities of waste expected to be generated, especially from a wide-area biological incident in a large city, could include entire city blocks of high-rise buildings and public transportation systems. Thus, it is anticipated that treatment and disposal capacities of the city and the surrounding areas are anticipated to be exceeded, and regional and national support would be required to assist with the overall response and management, amplifying the need for Pre-Incident WMPs to be developed and coordinated with federal, state and local plans prior to an incident.

It is especially important because each state – and their permitted waste management facilities – may have different requirements for biological agents, making it critical to have those requirements pre-identified. Otherwise, waste may not be accepted by waste management facilities in other states.

### *Estimated Types and Quantities of B. anthracis Waste*

The waste estimates for a *B. anthracis* incident will vary greatly depending on whether the incident involves a single building or a wide area. Overall, substantial limitations constrain the current ability to calculate waste estimates accurately for wide-area scenarios, reflecting uncertainty in the understanding of the many processes involved in a response to a *B. anthracis* incident of this magnitude and how these processes may impact waste quantities (New York City DOHMH, 2015). For example, because total waste generated is strongly influenced by the decontamination approaches chosen, uncertainties about how and which decontamination options would be employed during a wide-area *B. anthracis* incident result in significant variation in potential waste estimates. Waste management efforts are underway to continue to increase the understanding of the connections between waste generated and processes such as sampling and decontamination.

A description of the expected waste streams and the appropriate classification of these waste streams is shown in Table 8.

**Table 8. Classification of Expected Waste Streams.**

| Description of Items/Waste | | Waste Classification* | Waste Management Facilities |
|---|---|---|---|
| Liquid Waste | Decontamination wastewater, contaminated | HW, IW | Hazardous Waste Facility (e.g., incinerator) |
| | Decontamination wastewater, uncontaminated | NH/NI[2] | Publicly Owned Treatment Works (POTW)[3] |
| Solid Waste | PPE, contaminated | HW, IW | Hazardous Waste Facility (e.g., incinerator) |
| | PPE, contaminated | IW | Medical Waste Incinerator or Autoclave |
| | PPE, uncontaminated | NH/NI | Solid Waste Management Landfill |
| | Office Waste and General Trash (e.g., papers, PPE packing boxes), uncontaminated[1] | NH/NI | Solid Waste Management Landfill |
| | Building Materials (e.g., ceiling tiles, drywall, carpeting), uncontaminated | NH/NI | Solid Waste Management Landfill |
| | Furniture, uncontaminated | NH/NI | Solid Waste Management Landfill |
| | Electronic Waste, uncontaminated | NH/NI | Solid Waste Management Landfill |

* Waste Classification (as defined by federal, state, or local requirements as applicable)

- NH/NI: Non-hazardous and non-infectious through sampling or process knowledge
- HW: Hazardous waste as tested or through process knowledge
- IW: Infectious waste as tested or through process knowledge

[1] Office waste is not removed from the contaminated site, but is generated by response activities, and not exposed to contamination (or whatever the case may be).

[2] Items in the categories currently labeled NH/NI are actually contaminated, they might be in the HW/IW categories if removed rather than decontaminated on-site prior to transport and/or left in place (e.g., if drywall is removed from a contaminated facility for disposal because it is porous, then it is not NH/NI).

Source: (EPA, 2015)

[3] This can vary considerably; it should not be assumed that either the hazardous waste facility or the POTW will accept this. See Water Environment Research Foundation [WERF] (2016) for more information.

## 4.5 Worker Health and Safety

Following a biological incident, the health and safety requirements for all workers should be addressed and integrated into the overall mission of the response. Worker protection is a critical element of biological waste management in the aftermath of a biological incident. These workers include emergency responders, individuals that need to maintain critical infrastructure and key resources, and short- and long-term remediation and restoration workers. Regardless of the biological agent(s), the following should be addressed prior to managing any wastes:

- Understand the agent(s) of concern, exposure pathways, and all site hazards and risks.
- Federal workers are covered by OSHA requirements for federal agency occupational safety and health programs (29 CFR 1960).
- Non-federal workers are subject to a variety of protection depending on industry, jurisdiction, etc. All private sector workers are covered by OSHA. In states that operate their own OSHA-approved State Plans, public-sector workers are also covered. EPA standards extend HAZWOPER

protections to workers in states without a State Plan where federal OSHA covers private sector (but not public sector) workers.[2]

- Consult public health agencies for recommendations on medical countermeasures (prophylaxis, immunizations, and surveillance) prior to site response. Federal employees will be under the jurisdiction of the USPHS recommendations; non-federal workers will be subject to local public health recommendations.
- Consult with the federal, state, or OHSA staff on any specific health and safety guidance that may develop as a result of the specific incident.
- Ensure that comprehensive site health, safety, and emergency response plans are developed for the incident. Plans should address personnel medical clearance requirements, PPE, OSHA requirements, exposure limits and medical monitoring, medical surveillance, emergency response, site safety management, and training (discussed in Section 4.6) requirements.
    - For cleanup operations, OSHA's HAZWOPER Standard (29 CFR 1910.120 or 29 CFR 1926.65) requires a written health and safety plan (HASP), which identifies site hazards and appropriate controls to protect employee health and safety.

Requirements for HASPs for anthrax-contaminated sites can be found on OSHA's website https://www.osha.gov/SLTC/etools/anthrax/hasp.html (Accessed July 18, 2016). Note: each HASP should be tailored and specific to the incident and site.

## 4.6 Health and Safety Training

Personnel involved with waste management activities should be trained and possess the necessary experience and skills, including an understanding of decontamination processes, how to handle biological agents and biotoxins, the appropriate type and use of PPE (discussed in Section 4.6.1), appropriate packaging and labeling requirements, and necessary health and safety procedures. OSHA requirements for hazardous materials (HAZMAT) employees, as outlined in Standard 29 CFR 1910.120 or 29 CFR 1926.65, include the following training categories: general awareness/familiarization training for the hazard, function-specific training, safety training, security awareness training, and in-depth security training. Additional health and safety training for response personnel that may be required based on site hazards is outlined in Table 7.

For a *B. anthracis* incident, OSHA addresses training for workers related to this agent during response and remediation in an Anthrax eTool available online https://www.osha.gov/SLTC/etools/anthrax/index.html (Accessed July 18, 2016).

[2] EPA extends HAZWOPER protection to public sector workers in 40 CFR 311. EPA's purpose for adopting 29 CFR 1910.120 was to cover employees that OSHA could not otherwise cover.

### Table 7. Personnel Training Requirements Overview.

| Activity | Reference | Requirement |
|---|---|---|
| Emergency response to hazardous substance release | HAZWOPER, 29 CFR 1910.120(q)(6) | 24 hours training + depending on duties |
| Potential exposure to/ working with hazardous materials | HAZWOPER, 29 CFR 1910.120 | Specific training on materials that may be encountered/exposed |
| Potential exposure to bloodborne pathogens<br>- transmissible via blood, certain body fluids, and other potentially infectious materials | Bloodborne Pathogens (BBP), 29 CFR 1910.1030 | Training requirements for exposure hazards, exposure control plans, PPE, and other infection control elements |
| Use of PPE (including respirator) | Respiratory Protection, 29 CFR 1910.134;<br>other PPE standards, 29 CFR Subpart I | Understand when PPE is necessary; what PPE is needed; how to put on and take off; limitations; and proper care and maintenance |
| Working in noise hazardous areas | Occupational Noise Exposure, 29 CFR 1910.95 | Occupational Noise Exposure PPE, Training if exposed above 85 dBA |
| Entry into confined space | Permit-Required Confined Spaces, 29 CFR 1910.146 | Awareness of confined spaces and training prior to entry into permit required confined spaces |
| De-energizing circuits/ lockout/tag out | Control of Hazardous Energy (Lockout/Tagout), 29 CFR 1910.147;<br>Electrical Protective Equipment (29 CFR 1910.137) | Specific program training on control of hazardous energy |
| Potential exposure to hazardous chemicals used for decontamination | Hazard Communication, 29 CFR 1910.1200 | Provide workers with information about chemical hazards and how to protect themselves |
| Packaging, labeling, and marking for transportation of infectious waste | Hazardous Materials Regulations (HMR), 49 CFR 172.704 | Methods and procedures for avoiding accidents, such as the proper procedures for handling packages containing hazardous materials |
| Source: (New York City Department of Health and Mental Hygiene [DOHMH], 2015) | | |

### *4.6.1 PPE for Personnel*

All workers entering the exclusion zone or “Hot Zone” (illustrated in Figure 6 of Section 6) must wear appropriate PPE, notably respiratory protection. NIOSH recommendations for PPE during a response to a biological agent incident are based on site conditions and the dissemination method and nature of the release (EPA, 2015). Recommendations are as follows:

- Employers of cleanup workers must provide respiratory protection with an appropriate filter to protect workers from respiratory hazards. Cleanup workers are protected under the OSHA Respiratory Protection standard (29 CFR 1910.134), which requires medical clearance, fit testing, training, and other elements of a respiratory protection program beyond just provision of respirators. Respirators must always be used in accordance with the provisions of the Respiratory Protection standard.
- When the agent is unknown, dissemination with an aerosol-generating device is still occurring, and/or the event is otherwise uncontrolled, NIOSH recommends that each emergency responder

use a Level A protective suit with a NIOSH-approved, Chemical, Biological, Radiological, and Nuclear (CBRN) pressure-demand self-contained breathing apparatus (SCBA).

- When the suspected biological aerosol is no longer being generated but other conditions may present a splash hazard, NIOSH recommends that each emergency responder use a Level B protective suit with a NIOSH-approved, CBRN pressure-demand SCBA.
- When the agent has been identified and it can be determined that: 1) an aerosol-generating device was not used to create high airborne concentrations, or 2) dissemination was by a letter or package that can easily be bagged, NIOSH recommends that each responder use a filtering facepiece respirator (FFR) with a P100 filter or powered air-purifying respirator (PAPR) with high efficiency particulate air (HEPA) filters. Some EPA requirements may necessitate the use of NIOSH-approved CBRN-rated FFRs, though employers should be aware that FFRs and PAPRs have different assigned protection factors.

# 5. RESPONSE MANAGEMENT/AGENCY ROLES/RESPONSIBILITIES

In the United States, all levels of government – federal, state, territorial, tribal, and local – respond to disasters. Incident management refers to how incidents are managed by government officials, between multiple agencies and jurisdictions, and between phases of response and recovery (refer to Table 4). Federal agencies provide critical assistance to state, tribal, and local response organizations in the event of a disaster that overwhelms state and local capabilities. For incidents involving biological terrorism, different agencies are responsible for coordinating activities specific to their area of expertise (DHS and EPA, 2009). As discussed earlier in the document, the NRF provides guidance for response functions immediately following an incident, including two incident annexes applicable to this SOG, the Biological Incident Annex and the Food and Agriculture Incident Annex.

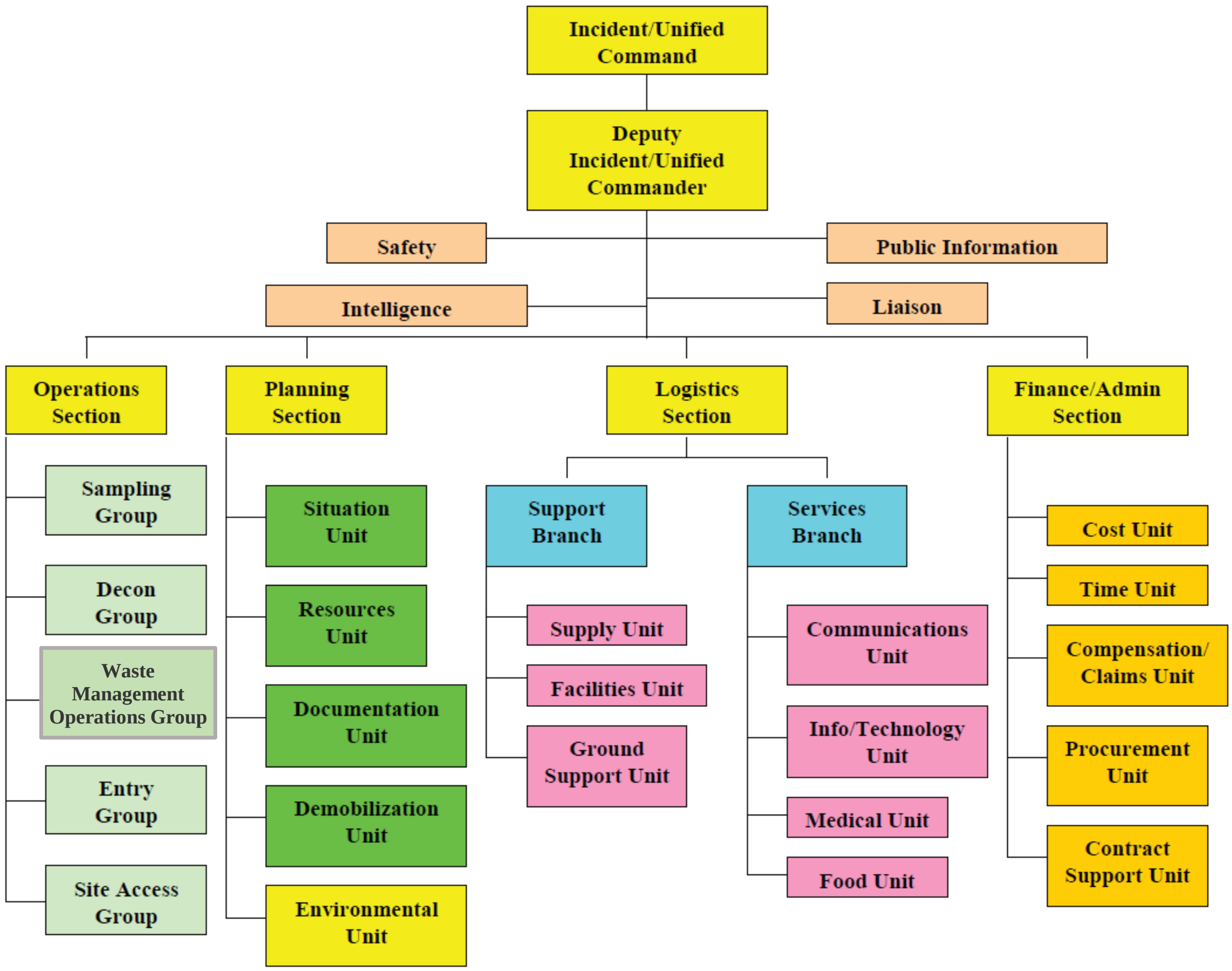
Response to biological incident will be managed using the incident command system (ICS) based on the National Incident Management System (NIMS) (DHS, 2008d). ICS is a standardized, on-scene, all-hazards incident management approach allowing its users to adopt an integrated yet flexible organizational structure to match the complexities and demands of single or multiple incidents. ICS allows facilities, equipment, personnel, procedures, and communications to be integrated and operated within a common organizational structure. ICS coordinates response among various jurisdictions and public and private entities and establishes a common process for planning and managing resources.

The response process will be managed by the IC/UC, which ultimately determines the structure and organization of the Incident Command Post. A strong, coordinated IC/UC will be instrumental in overcoming the challenges of biological agent waste management. Figure 5 shows an example of the IC/UC structure following a biological incident.

In general, a wide area release of biological agents will make a response much more complicated, and there is limited waste management expertise available across all levels of government to handle waste streams that may never have been managed before. Therefore, these best practices recommend the inclusion of a “waste management operations group” within the planning and/or operations section comprised of pre-identified subject matter experts able to conduct the extensive level of coordination required for wide area biological incidents that require waste management facilities across multiple states and regions. Decisions regarding sampling, decontamination, strategies, public health and risk assessment, and waste management will be made based on information from analyses conducted by appropriate experts in the environment unit within the planning section (DHS and EPA, 2009).

The IC/UC is tasked with developing an overall decontamination strategy that will guide the development and execution of all remediation activities. The overall goal of the decontamination strategy should be to achieve the clearance goals (see Section 11) while reducing the expenditure of time and resources required to recover a wide urban area following a biological incident.

Issues that cannot be resolved at the IC/UC level may be elevated to the Joint Field Office (JFO) Unified Coordination Group for resolution. The JFO Unified Coordination Group may also wish to review and provide input on decisions related to extensive contamination (and remediation costs) and in situations where it may be necessary to set priorities among multiple contaminated sites (DHS and EPA, 2009).




Source: (DHS and EPA, 2009)

**Figure 5. Example of incident command structure for biological incident.**

## 5.1 Resource Personnel Needed from Response Management

It is critical to identify the waste management resource personnel and wastewater management authorities that will be needed at the federal, state and local level since federal response teams will not necessarily have the knowledge of the state and local facilities and resources, unless they have familiarized themselves ahead of time. Experience has demonstrated that representatives from the local public works departments including the sanitation, water and wastewater departments will be needed, as well as the local planning and transportation departments (i.e., access to city and facility maps/drawings), as they are critical for waste management activities including staging, transportation, storage, and packaging.

In addition, vetted sampling teams and contractors, environmental monitoring teams and contractors, data management and documentation specialists, PPE suppliers, facilities engineering and construction teams, fate, transport, and exposure pathway modeling teams and contractors, and decontamination and fumigation teams with adequate training and resources should be used to perform necessary duties.

# 6. BIOAGENT WASTE MANAGEMENT OPERATIONAL CONCEPTS

For most scenarios involving a wide-area release of a biological agent, unprecedented amounts of waste would be generated during remediation. The initial stages of the waste management process, but also specific factors (refer to Figure 4) to be considered when conducting pre-incident planning, involve identification, segregation, and staging or temporary transfer of waste generated from response operations. Further needs to consider include anticipated waste streams, sampling and analysis for waste classification and identification, and WAC associated with different waste management options/facilities.

As soon as possible after determining that a biological release has occurred and emergency public health issues are addressed, it is necessary to distinguish among, and set boundaries for, three preliminary zones. The standard zone designations depicted in Figure 6 are used to guide subsequent cleanup and environmental sampling activities and to reduce contamination as well as the likelihood of recontamination of areas already cleared (DHS and EPA, 2009).

**Exclusion Zones ("Hot Zones")**

- Areas where contamination is either known or expected to occur and where the greatest potential for future exposure exists. Access to and egress from an exclusion zone should be restricted to access control points. All persons who enter an exclusion zone must wear the appropriate level of PPE for the degrees and types of hazards present (per OSHA guidance).

**Contamination-reduction Zones ("Warm Zones")**

- Areas surrounding a Hot Zone (likely quite large in extent in a wide-area attack) that may pose low, but some potential health risk. Here, decontamination takes place for personnel, equipment, and items coming out of the Hot Zone. Such zones are the transition area between an exclusion zone and support zone (see below). The purpose of a contamination-reduction zone is to reduce the possibility that a support zone will become contaminated or affected by site hazards.

**Support Zones ("Cold Zones")**

- Uncontaminated areas that may be safely used as planning and staging areas where workers are unlikely to be exposed to biological agents or dangerous conditions. Because support zones are free from contamination, personnel working within them wear normal work clothes. Support zones are designated as such from all available site characterization data and should be located upwind from exclusion zones. Cold zones may change in response to environmental conditions such as wind and rain and must be monitored over time.

**Figure 6. Contamination Site Standard Zone Designations.**

***OSHA Anthrax Risk Reduction Matrix***

The designations in Figure 6 should not be mistaken with OSHA's three risk zones of categorizing the likelihood of anthrax-contaminated worksites: green, yellow, and red, where the green indicates contamination with anthrax spores is unlikely, yellow indicates contamination with anthrax spores is possible, and red indicates contamination with anthrax spores has been confirmed or is strongly suspected. This information can be found separately online at: https://www.osha.gov/SLTC/etools/anthrax/risk_eval.html (Accessed July 18, 2016).

## 6.1 On-site Decontamination

When on-site decontamination is going to be performed, technologies that can be used as barriers in preparation for decontamination include sheeting materials used as isolation barriers inside a facility; building tents to seal structures; and sheeting to cover glass for ultraviolet protection. Sheeting materials and tarps can also cover and confine outdoor areas identified as hot spots or as physical barriers for fumigants applied outdoors. Other materials such as sealants and tapes (e.g., glues, foam, and caulking) are required to provide airtight seals and to cover joints and nails. Materials used as part of fumigations should have gas-resistant properties and provide airtight installations.

In preparation for outdoor decontamination, initial actions such as application of surface fixatives or binders, or physical removal by a variety of methods should be taken to prevent the spread of contaminants. These initial actions are advantageous because they can inhibit potential resuspension and cross-contamination, while allowing additional time for response personnel to consider prioritization, response planning, and actions for more thorough follow-on decontamination. For indoor facilities where fumigations or liquid decontamination will be performed, prior HEPA vacuuming may be used, especially on porous surfaces, to physically remove the agent from the item and reduce the amount of contaminant that can interfere with subsequent decontamination.

The following recommendations are provided to maximize the efficiency of biocontaminated waste handling operations while minimizing exposure to the personnel involved in the process:

***Best practices to minimize exposure***

- *Construct appropriate isolation barriers using appropriate sheeting materials for specified decontamination methods;*
- *Use sealants and tapes to provide airtight seals and to cover joints and nails;*
- *Perform source reduction of materials as appropriate for outdoor and indoor sites; and*
- *Prevent contaminated water from decontamination operations, precipitation run-off, etc. from running off into uncontaminated areas.*

To prevent further contamination or an unintentional release into the environment or the community, all personnel, PPE, tools, machines, structures, devices, vehicles, and surfaces that have been in contact with the suspected biological waste should be decontaminated or treated before being sent to an authorized recycling or waste management facility. Based on past emergency response efforts, it is likely that all waste will be required to be decontaminated before transport to disposal facilities. Therefore, waste should be minimized, and decontamination strategies should incorporate *in situ* (or on-site) decontamination (see Section 6.2.1) and reuse whenever possible (Raber et al., 2011).

Recommendations for managing waste generated during decontamination of humans, animals, site premises, and vehicles are listed below. Potential decontamination technologies and their appropriate application is presented later in Section 8, Table 10.

## 6.2 Human Decontamination

CBRN incidents present different challenges for all responders, necessitating the rapid decontamination and treatment of a significant numbers of casualties while taking critical measures to ensure the well-being of the personnel managing the incident. Decontamination of personnel after a biological warfare attack is a lesser concern than after a chemical warfare attack for instance because most biological warfare agents are not dermally active. Still, decontamination remains an effective way to decrease the spread of infection from potential re-aerosolization.

If personal decontamination is deemed appropriate, persons (e.g., victims) should remove their clothing and personal effects, place all items in plastic bags, and shower using copious quantities of soap and water. All workers entering the exclusion zone or Hot Zone must don and use/wear appropriate PPE for all steps, notably respiratory protection. Located in the designated Warm Zone of an incident will be a decontamination station to decontaminate workers and their equipment when exiting the Hot Zone. Decontamination in the Warm Zone ensures that individuals are not contaminated by materials in the Hot Zone while removing their PPE and that they do not contaminate the clean site of the area (Cold Zone). For human decontamination, mechanical decontamination is conducted to physically remove the potential contaminant by washing with soap and water. For PPE or non-sensitive equipment, chemical decontamination is performed by applying disinfectants to inactivate the biological agent.

The objective of disaster triage (field triage) is to do the greatest good for the greatest number of people. Effective triage requires significant planning and an infrastructure that can support the process during a disaster. Trained and qualified triage personnel should determine priority of treatment and decontamination. In addition, the various decision-making activities related to decontamination should be executed in a flexible manner, depending on the victim's general state, the physical nature of the agent (gas, aerosol, droplet, splash, liquid, powder, etc.), as well as the season, weather conditions, and other factors (Okumura et al., 2007).

Decontamination triage is the prioritization of victims for decontamination based evidence of contamination and/or exposure to the hazard. It is a prioritization mechanism used by first responders to determine whether victims emerging from a biological incident scene should be directed to area(s) of safe refuge/observation area or to a mass casualty decontamination station. *Note:* Decontamination Triage is not the same as Medical Triage, which is performed to determine who should receive medical treatment first (Lake et al., 2013). No medical care is provided to patients during the time spent waiting to begin the decontamination process. Therefore, the patient must be stabilized to an extent that their condition will not deteriorate during this time. In a contaminated environment, emergency care is given by personnel in the highest level of mission-oriented protective posture, whose capabilities are limited by their protective gear. After receiving emergency care, a casualty must go through the decontamination station before receiving more definitive care in a clean environment (Ramesh and Kumar, 2010).

According to Lake et al. (2013), principles of mass casualty decontamination for a biological incident include:

1. Time is critical in order to save the most lives; a) the immediate removal of clothing outside the contaminated area for patients who have been visibly contaminated or who have been suspected of having been contaminated and b) processing the victims through a high-volume, low-pressure water shower (~50 to 60 pounds per square inch [psi]) is priority. This may aid in the removal of 80-90% of physical contamination in almost all cases.

    a. Initial decontamination wash time should be between 30 seconds and three minutes in duration to ensure thorough soaking, depending on the situation and agent involved.

    b. Safe/refuge observation areas should be utilized to monitor victims for signs of delayed symptoms or evidence of residual contamination.

    c. Secondary decontamination should be performed as necessary, where the setup of secondary decontamination should not delay primary decontamination.

2. Provide effective mass casualty decontamination. Other activities, such as setting up commercial decontamination tents, tarps, additional decontamination equipment, and/or creating a soap-water solution should be accomplished when time permits.
3. Conduct decontamination triage prior to administering a high-volume, low-pressure water shower.
4. Use gentle friction (such as rubbing with hands, cotton flannel or microfiber cloth, or sponges) is recommended to aid in removal of contamination. Rubbing should start with the head and proceed down the body to the feet. Extra care should be taken to prevent the spread of contamination to the mouth, nose and eyes (such as holding one's breath to avoid inhalation/close contact with mucosa and closing one's eyes while wiping the face and head).

If on site treatment is not possible or advisable, wastes may have to be properly packaged and transported to a state or locally approved waste-treatment facility capable of destroying any remaining spores. Depending on the capacity of available facilities and the size and volume of wastes to be treated, medical or other equivalent types of waste-treatment facilities might need to be used (Raber et al., 2011).

Sensitive items may be moved to another spot within the site for decontamination by placing the item in a large standardized shipping container (i.e., Conex box) or other enclosure near the decontamination site (New York City DOHMH, 2015). Items designated for off-site decontamination will need to be removed and labeled/tagged for tracking and enclosed to avoid contamination during transport. Once inside the enclosure (i.e., Conex box), the items can be fumigated using techniques suitable for sensitive items (e.g., ethylene oxide) allowing them to be treated for reuse.

### *In situ Waste Decontamination for B. anthracis*

*B. anthracis*-contaminated waste may be stored for further treatment or pending If personal decontamination is deemed appropriate, persons (e.g., victims) should remove their clothing and personal effects, place all items in plastic bags, and shower using copious quantities of soap and water. Plastic bags with personal effects should be labeled with the owner's name, contact telephone number, and inventory of contents. Personal items may be kept as evidence in a criminal trial or returned to the owner if the threat is unsubstantiated. Evidence or personal items should be double-bagged and decontaminated on the outside with an EPA approved sporicide (e.g. PERIDOX ® or Steriplex Ultra™) prior to removal from the Hot Zone. Note: To-date, these are the only two liquid sporicides approved by EPA effective against *B. anthracis*. If possible, *B. anthracis*-contaminated wastes should be treated on site to reduce or destroy spores, tested to confirm treatment effectiveness, and treated further, if necessary, until post-treatment sampling shows no indication of viable spores. If such a process is followed, treated wastes may possibly be disposed of as municipal solid waste (MSW) or wastewater, given approval from appropriate state and local authorities. However, the procedure for obtaining such approval is not currently well defined, and state and local authorities may face technical and non-technical challenges when determining if such approval is warranted (WERF, 2016).

## 6.3 Animal Decontamination

Animal decontamination is a complex mission area that requires a commitment of time and the engagement of those with expertise in the science and management of animals and hazard incidents. Without such commitments, responders may be exposed to additional health risks and animal suffering may be increased. Animal decontamination should be integrated into the overall planning when conducting exercises for actual incidents. Local or state incident management teams may consider incorporation of Animal Branch Managers or Animal Group Supervisors as an element of their planning process. Animal agencies or organizations should participate in training and exercise programs with emergency managers and planners when appropriate to facilitate familiarity with all aspects of hazardous materials incidents and identify additional capability/training needs. Planning should be conducted for diverse animal groups, which may include the following:

- Service animals;
- Working animals;
- Pets (from households and animal facilities such as from veterinary hospitals, animal control/shelter facilities, boarding kennels, and pet breeding facilities);
- Livestock and poultry;
- Wildlife (native/free-ranging and managed, such as from zoos, aquariums, sanctuaries, etc.); and
- Research facility animals.(National Alliance of State Animal and Agricultural Emergency Programs (NASAAEP) Best Practices Working Group, 2014).

Veterinary and animal care personnel working anywhere in the animal decontamination line should at a minimum be in the same PPE as the unit conducting other types of decontamination activities. A triage tent for veterinary care should be planned prior to the decontamination line to determine if the animal is contaminated, or has any life, limb, or eyesight injuries that need to be treated, or what to do with the animals that are likely to develop disease following the incident (e.g., if they have ingested, inhaled, or otherwise been exposed to a pathogen with a certain latency or incubation period). Animals with major injuries may need to be stabilized prior to decontamination when resources are available. If such resources are not available or if providing veterinary care creates an unacceptable risk to responders (e.g., severe injury or illness), euthanasia may need to be considered. Uncooperative or dangerous animals may need to be sedated prior to decontamination.

Mass animal decontamination may be necessary from a wide-area event and may require gross decontamination and/or temporary sheltering the animals in a Warm Zone. Equipment used in the decontamination of humans or equipment may be applicable to animal decontamination. The animal may need to be decontaminated several times before it is considered “clean” enough to be near unprotected people. If animals ingest contaminants, the animal’s waste may then be contaminated and need to be handled as such; therefore, consideration should be given to a method of collecting and testing the animals for contamination. A triage tent for veterinary care should be planned at the end decontamination line as well to reassess the animals after decontamination to determine if they are healthy enough for transport or clean enough to leave the site. Following decontamination, signs of internal contamination or future disease development will need to be monitored for by the owner or the receiving shelter or veterinary clinic (NASAAEP Best Practices Working Group, 2014). A latency period should be determined by veterinary staff.

If deemed necessary, animals should be euthanized in accordance with the American Veterinary Medical Association (AVMA) guidelines (AVMA, 2012). Depending on the incident, it may be unrealistic to follow these guidelines due to responder safety and/or resource availability (e.g., in incidents involving large populations of livestock or poultry, these operations are referred to as depopulation rather than euthanasia). In general, performing life-ending operations requires owner permission or direction from the appropriate regulatory authority (NASAAEP Best Practices Working Group; 2014). If laboratory analysis of carcasses is needed, a protocol for sample collection and submission must be developed prior to the emergency.

When euthanizing animals, procedures for how carcasses will be disposed should be determined. Carcass disposal may be by burning, burial, composting, or rendering, pending state and local approval. A list of rendering plants, crematoria, and heavy earth-moving equipment suppliers should be identified in the response planning. If mass burial is to be conducted, state and local environmental officials should be consulted to ensure that the burials will not contaminate water sources or harm other natural resources (AVMA, 2012). On-site management (e.g., on-site composting) minimizes biosecurity concerns involved in moving contaminated carcasses, animal products, and other materials off an affected premise(s). On-site composting has been shown to be a successfully used practice based on its effectiveness by inactivating the virus in avian influenza outbreaks. However, USDA recognizes that not all types of poultry operations (e.g., live bird markets) lend themselves to on-site management. Therefore, secure transport to an off-site treatment/disposal facility may be necessary (EPA, 2006).

## 6.4 Premises Decontamination

Decontaminating an area contaminated by a biological agent involves numerous issues specific to an individual location. For example, hard, nonporous surfaces can be treated relatively effectively with a variety of decontamination approaches, whereas outdoor surfaces can be highly porous or contain large amounts of substances that can react with the decontaminant or otherwise interfere with efficacious decontamination (e.g., organic components in soil and dust) and therefore require careful evaluation to determine an effective decontamination strategy. In general, on-site treatment options include HEPA vacuuming, anti-microbial disinfectants, and fumigants. Specific examples of decontamination methods, their suitable usage conditions and phase of use during the decontamination process (source reduction or treatment), and handling post-decontamination are outlined later in Table 10.

Prior to off-site decontamination, gross decontamination can be conducted, generally involving performing preliminary surface treatments and physical removal of items not conducive to decontamination. In some circumstances, gross decontamination may be sufficient to achieve the clearance goals. Gross decontamination may involve the following activities:

- Treating identified hot spots;
- Removing items/materials not conducive to decontamination methods;
- Cleaning surfaces to facilitate decontamination methods; and
- Decontaminating non-removable, sensitive items *in situ*.

## 6.5 Vehicle Decontamination

During a response, there will likely be two basic categories of vehicles present:

- Commercial/industrial vehicles, including emergency response and service vehicles (i.e., fire trucks, squad cars, ambulances, hearses, buses); and
- Personal (commuter-type) vehicles (i.e., family cars, taxis, vans).

It may be useful to dedicate some commercial/industrial vehicles to the exclusion zone (Hot Zone) where PPE is routinely worn and to subject the vehicles to routine washing with a bleach solution to control excessive contamination. At the conclusion of the response action, a comprehensive decontamination of each vehicle would be needed prior to returning the vehicle to normal duty (New York City DOHMH, 2015).

Vehicle decontamination is particularly challenging since most vehicles are primarily made up of porous surfaces, and they have HVAC systems that cannot be directly accessed. It may be beneficial to evaluate the degree and location of contamination on the vehicle interior and exterior surfaces and HVAC system before beginning the decontamination. This assessment should include a history to determine if the vehicle was in an area where contamination was present and the operating state of the vehicle at the time. Many options are possible, including the following:

- The vehicle may have been parked, not operating, and secured at the time of the release;
- The vehicle may have passed through/by the contamination plume;
- The driver may have tracked contamination into the vehicle; or
- The vehicle may have been sitting in traffic with the HVAC operating or the windows open when the plume passed by (New York City DOHMH, 2015).

Understanding the level and character of contamination would allow for the decontamination method(s) of least complexity to be employed and field tested during the incident. For example, if sampling verifies that contamination was merely tracked into the vehicle, then a thorough shampooing with a decontamination agent of the carpets, seats, and other surfaces may be adequate to return the vehicle to its owner. For personal vehicles, if the vehicle is contaminated to any real extent, fumigation might be the most reliable method to render it safe for use (New York City DOHMH, 2015).

The EPA has developed a “Quick Reference Guide” for addressing decontamination of vehicles that enter the Hot Zone after an incident has taken place (EPA, 2016c). Examples include vehicles used for the purpose of transporting personnel for sampling, decontamination, evidence collection, law enforcement, retrieval of high-value items, or similar activities. Following development and review of a decontamination plan, pre-entry strategies should be implemented in an effort to decrease decontamination efforts including (EPA, 2016c):

- Replacing porous, difficult-to-decontaminate vehicle parts with nonporous, easier-to-clean parts to facilitate cleaning and application of decontaminants, when possible.
- Adding enhanced cabin filtration by replacing the cabin air filter with a higher-efficiency cabin air filter that is appropriate for the agent.
- Covering non-replaceable, porous equipment, tools, and vehicle parts (e.g., seat cushions, electronic components) with plastic that can minimize the need for decontamination.

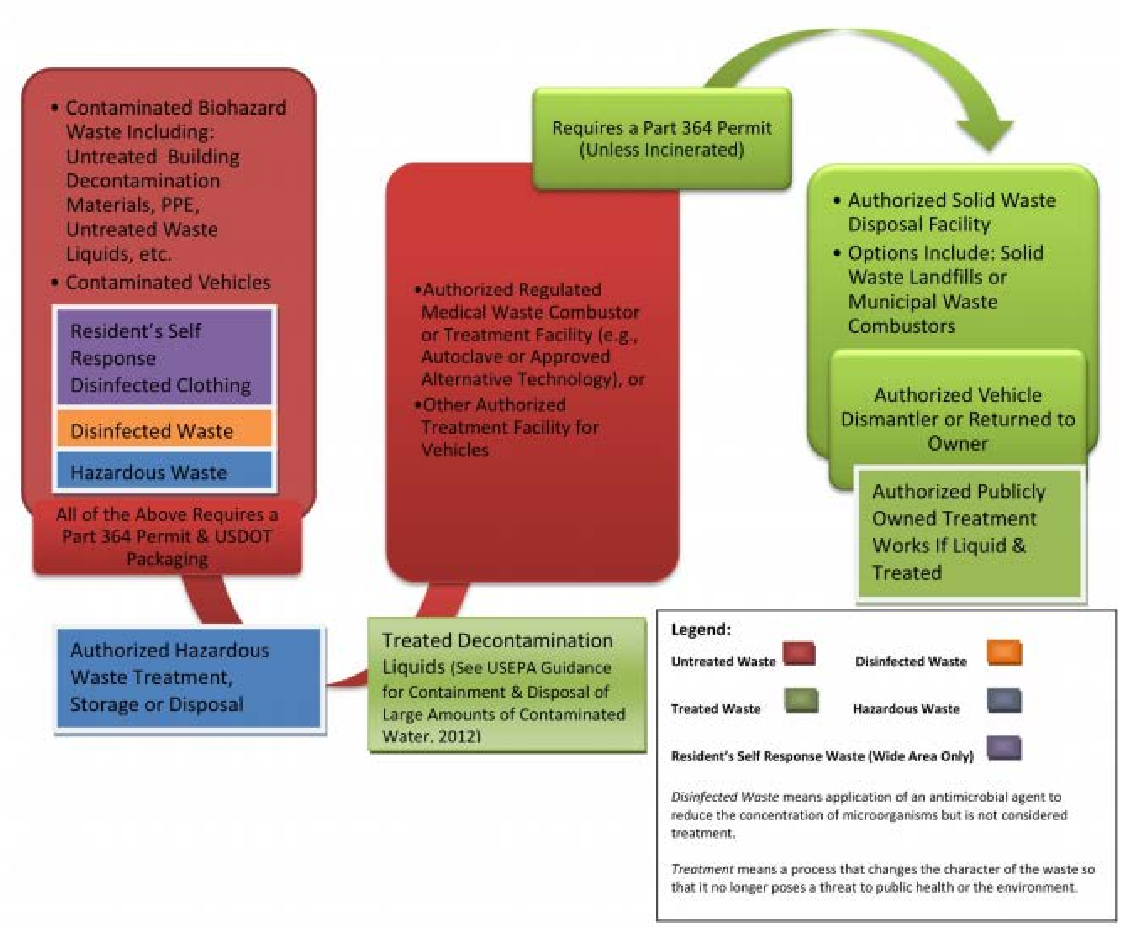
# 7 SOURCE REDUCTION, SEGREGATION, STAGING, AND PACKAGING, FOR BIOCONTAMINATED WASTE

Waste management activities following a biological incident may include methods and protocols for waste handling, treatment, packaging, transportation, and disposal operations. A strategy for waste management activities should identify a process flow of waste to include where waste will be generated, what waste will be generated, how much will be generated, the rate of waste generation, and the physical state (solid, liquid, gas) of the waste (EPA, 2015).

## 7.1 Waste Handling

Reducing the number of times the waste is handled and facilitation of a smooth, timely, and efficient response is important. Items intended to be recycled or discarded as waste should be separated as soon as feasible, including on site, to allow creation of waste streams that can be managed in a manner most appropriate for each waste stream. In addition to waste generated during remediation activities, there will be a large number of patients seeking medical treatment in this type of scenario, thus causing an increase in waste generation at medical facilities. Therefore, the handling of this medical waste should be addressed as part of pre-incident planning, otherwise it will interfere with the overall cleanup and recovery effort for the remaining impacted area. Further, while the response and recovery is occurring, normal waste management practices still need to occur for those areas outside the contaminated area; normal waste also may increase as people dispose of their marginal belongings (believed to be uncontaminated) creating a larger flow of normal waste. The handling of this waste should also be planned in the overall incident response because there will be competition for the same disposal resources.

In an effort to aid in the waste management activities, a visual depiction of the waste flow may be helpful. The example diagram shown in Figure 7 identifies where and how the waste may be generated, the types of waste likely to be generated, the physical state of the waste, and steps guiding the management of waste from a biological incident. This type of visual depiction enables waste management decisions based upon an understanding of the incident, the release, and the overall response strategies. Note that this is an example generated for a particular purpose, and that such a diagram arise from a particular incident may look significantly different.  The contents of the example should not be taken to infer a general recommendation.




Source: (New York City DOHMH, 2015)

**Figure 7. Waste Management Flow Chart for a Biological Incident.**

## 7.2 Segregation and Source Reduction

Segregating the waste before other activities (e.g., packaging and transportation) minimizes costs and maximizes environmental benefits. Therefore, a collection strategy should be developed, preferably prior to an incident or immediately after an incident, that allows for separating the waste based on contaminant, material type, or management method.

Prior to the commencement of decontamination activities, certain items and/or materials may be removed from a contaminated site for further treatment and reuse or disposal. As previously discussed, items remaining on-site and/or surfaces may be cleaned before the main decontamination event. This preliminary cleaning is performed in an effort to: 1) reduce the number of potentially contaminated items/materials present, 2) remove any material that might inhibit decontamination, and 3) reduce high levels of contamination prior to full decontamination (DHS and EPA, 2009).

The items that are subject to removal can be grouped into essential (sensitive) or non-essential items, as outlined in Table 8.

### Table 8. Source Reduction Material Categories.

| Item/Material Designation | Description | Examples |
|---|---|---|
| Essential | Items that must be protected, removed for decontamination elsewhere (e.g., regulated sterilization facility), and saved or restored for later use | Certain artwork, essential computer data, expensive medical equipment, valuable documents |
| Non-essential | Items that must be removed, treated, and disposed or recycled. The time and cost to remediate items for reuse needs to be evaluated against the time and cost to dispose as waste. | Site debris, items that may inhibit decontamination, low-cost items, exposed foodstuffs, exposed perishables |

Information derived from: (Raber et al., 2011); (DHS and EPA, 2009).

Decisions for which non-essential items will be removed from the contaminated site will have to be made on a case-by-case basis. Cost-benefit analyses for removing the items versus performing the decontamination *in situ* will need to be performed. In general, non-essential items removed from the site are pre-treated (e.g., diluted bleach), as appropriate, and placed in packaging specified by the DOT and state and local governments. Essential items are not pre-treated and are packaged the same as non-essential items. These packaged items are then treated, removed from the facility and transported to the appropriate off-site facility (discussed later in Section 10). The items will then be disposed of as waste or further treated for disposal, recycling, or reuse (DHS and EPA, 2009).

The following recommendations are provided to maximize the efficiency of biocontaminated waste handling operations while minimizing exposure to the personnel involved in the process:

***Best practices to minimize exposure***

- *Clearly label and segregate waste into essential and non-essential items;*
- *Separate segregated items based on material type and/or management method;*
- *Promptly perform source reduction outdoors to reduce contaminant load and the potential for spread early after an incident;*
- *Limit number of workers involved in these source reduction activities;*
- *If it is known that settled bioagent (e.g. B. anthracis or biotoxin aerosols) exists, use suppressants by misting or wetting area, without producing significant amounts of runoff water, to reduce airborne concentrations and the likelihood of re-aerosolization and airborne exposure;*
- *Vacuum surfaces only with a system containing HEPA filters;*
- *Vacuum debris captured in HEPA filters must be double-bagged, bleached, and decontaminated before disposal in off-site waste handlers; and*
- *Appropriately decontaminate any residual bioagent remaining on a surface following vacuuming.*

## 7.3 Waste Staging

Relevant issues to consider in evaluating staging and temporary transfer locations include whether the waste will be protected from weather and if there are methods to ensure that there is no release of contaminants, security measures against vandalism are in place, and monitoring is available. In the event the primary staging and temporary transfer areas or the potential management facilities identified in the Pre-Incident WMP are no longer available following an actual incident, alternatives to these types of sites or facilities should be identified in advance and documented in the Pre-Incident WMP.

The amount of time the waste is held at the staging location prior to transport off-site should be limited. Waste contaminated with an infectious agent should not be staged for more than 14 days or placed at temporary transfer locations longer than necessary (New York City DOHMH, 2015). In cases where it is necessary to store the waste for an extended period of time, approval from a regulatory agency may be required (New York City DOHMH, 2015).

If the waste is staged on vehicles, local and state requirements may preclude queuing these vehicles on streets. Therefore, responders and waste transporters should pre-identify in the WMP (or identify early in the response) how and where waste will be staged and identify short- and long-term staging or temporary transfer capacity, both on- and off-site. Waste should be staged in the transport vehicles where feasible (New York City DOHMH, 2015).

If specific sites cannot be identified in advance, a list of selection criteria for selecting appropriate sites should be identified during the pre-incident planning stage, so that when an incident occurs there is an accessible way to identify and select from suitable sites. Selection criteria may include such items as drainage, accessibility, proximity to wetlands, potential for impact to endangered species, environmental justice concerns, etc.

The following recommendations are provided to maximize the efficiency of biocontaminated waste handling operations while minimizing exposure to the personnel involved in the process:

***Best practices to minimize exposure***

- *Choose location(s) with an understanding of the workflow around the activity being staged, considering the size of the area required and protection from environmental factors;*
- *Clearly identify the purpose for activities to be conducted in the staging area(s), and the individuals who are authorized to enter the area(s);*
- *Verify that methods employed do not cause an unintentional release/spread of contaminants;*
- *Limit the amount of time contaminated waste is staged;*
- *Implement security measures and monitor the staging area(s);*
- *Stage packaged untreated waste or waste that has not been effectively treated by waste type in separate primary containers and in separate locations from waste that has been effectively treated to meet the established clearance level; and*
- *Place properly packaged untreated or ineffectively treated waste on an impermeable surface, labeled and secured to prevent unauthorized access. Use additional containment methods, such as berms and absorbents, as necessary, to prevent a liquid release.*

### 7.3.1 Waste Packaging and Tracking

It is important to note that DOT HMRs govern packaging and transportation. Refer to Section 10.1 for an overview of the DOT and CDC regulations for transporting hazardous materials. Items that require treatment off-site might be appropriately packaged prior to transport. For instance, treated and untreated waste might be placed in a bag (primary container), sealed, labeled, and, if possible, placed in a second bag before being placed in metal or fiberglass bulk outer packaging or a caster cart. After sealing, the outside of each bag and the outer packaging might be cleaned with a sodium hypochlorite solution prior to being transported off-site (New York City DOHMH, 2015). The relevant authorities should be consulted to determine if waste containers require special markings (e.g., biohazard). For agents that are bloodborne pathogens, employers may also need to comply with OSHA BBP standard packaging requirements. Also, if treating off site, there may be a need to comply with provisions of a DOT special permit for waste hauling.

Sensitive items should be tracked by establishing a label/tag system such as using evidence tags or labeling bags with a predetermined nomenclature system. Bar coding or other electronic tracking may be the most efficient method, given the quantity of items that will probably need to be handled. Example specific step-wise guidelines (derived from New York City DOHMH, 2015), for removing such items are summarized in Figure 8.

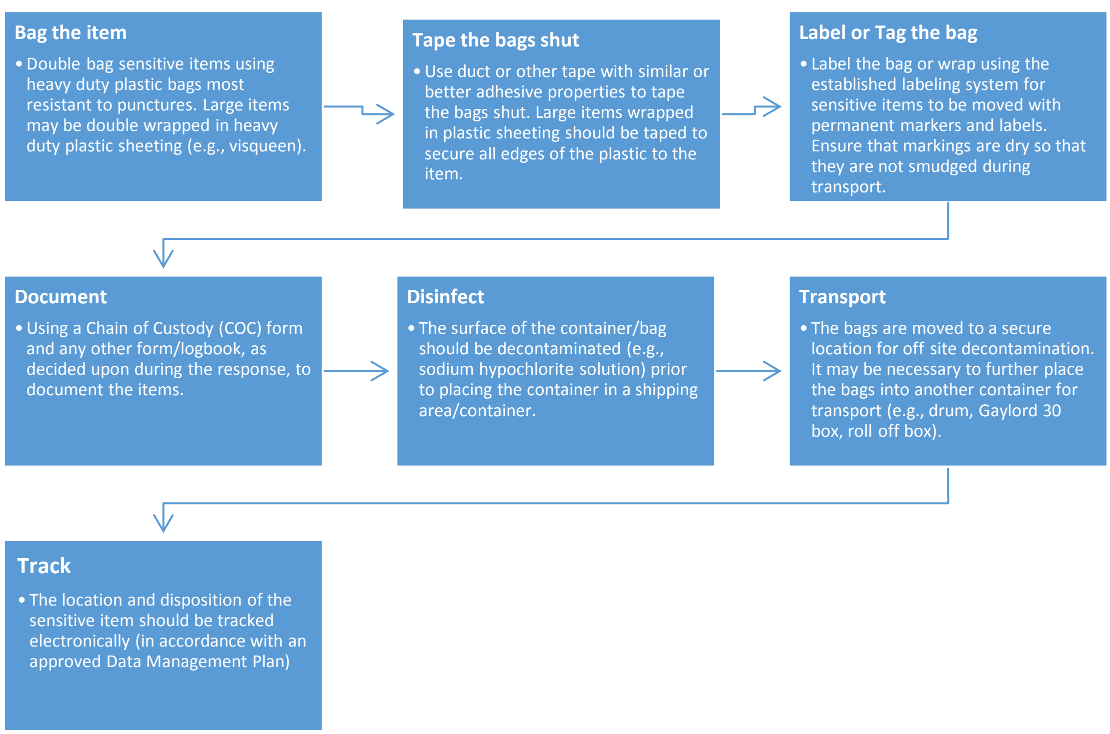



**Figure 8. Packaging and Tracking Process for Sensitive Items for Off-site Decontamination.**

If the contaminated waste cannot be packaged and transported in accordance with the HMRs due to the larger volume of waste generated as result of a wide-area incident, a special permit may be necessary. DOT may grant a special permit if the applicant can demonstrate that an alternative packaging will achieve a safety level that is at least equal to the safety level required under the HMR or is consistent with the public interest if a required safety level does not exist. More information on transporting infectious substances, emergency processing of special permits, and their associated HMR requirements can be found online at the link below.[3]

### *Waste Packaging and Tracking for B. anthracis Incident*

*B. anthracis*-contaminated waste may be stored for further treatment or pending characterization results in sealed containers that are appropriately labeled. If waste is temporarily stored before transport to off-site disposal, it must be in containers that meet the DOT Division 6.2 (Infectious Substances) packaging requirements and follow DOT HMRs. The storage area should provide weather protection and prevent access by unauthorized individuals or vermin. Items containing hazardous materials (e.g., asbestos) or radioactive materials contaminated by *B. anthracis* spores create additional considerations, as the waste in these items is more difficult to handle and appropriate precautions are required for their disposal (Raber et al., 2011). Again, the appropriate state authorities must be consulted to establish proper waste management procedures for unique waste streams.

The following recommendations are provided to maximize the efficiency of biocontaminated waste handling operations while minimizing exposure to the personnel involved in the process:

### *Best practices to minimize exposure*

- *Correctly don and use/wear appropriate PPE for all steps. Apply caution when removing PPE. Taking off PPE appropriately is important (i.e., to avoid self-inoculation).*
- *Triple-package waste in: 1) primary watertight receptacle, 2) watertight secondary packaging, and 3) rigid outer packaging.*
- *Place sharps waste in an authorized sharps container, and close and seal it in accordance with the packaging instructions for that container.*
- *Once items are in the first bag, close the plastic film bag by tying the bag with a knot or other equally effective positive means of closure that will not tear or puncture the outer bag or liner (such as heat sealing, tape, or adhesive) and will ensure any liquid contents will not leak from the packaging.*
- *Disinfect the exterior surface of the plastic bag with an appropriate (i.e., EPA approved) agent.*
- *Place the first plastic film bag, with the knot facing upward, into a second plastic film bag and close the plastic film bag as previously described for the first bag, making sure the primary bag does not interfere with closing the second bag.*
- *Disinfect the exterior surface of the plastic bag with an appropriate (i.e., EPA approved) agent.*

[3] DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) Transporting Infectious Substances Available online: http://phmsa.dot.gov/hazmat/transporting-infectious-substances (accessed 4/19/2016).

- *Place in an outer package made of rigid UN standard or DOT-approved non-bulk packaging (if the outer packaging is fabricated from fiberboard, it must be a minimum of triple wall and contain a 6-mil polyethylene plastic liner) with a maximum capacity of 55 gallons.*
    - *Place absorbent material sufficient to absorb all free liquid (if any) in the bottom of the rigid outer packaging or the liner of the fiberboard outer packaging.*
    - *Place the double-bagged waste into the rigid outer packaging or into the outer fiberboard packaging with an installed liner.*
    - *Close the liner (if used) either by zip tie or other equally effective means of closure or as specified by the manufacturer of the packaging.*
    - *Securely close the outer packaging as specified by the manufacturer of the packaging.*
- *For packaging of larger items, enclose the item in two layers of plastic sheet meeting the following requirements:*
    - *All sheets must be marked and certified by the manufacturer as having passed tests prescribed for tear and impact resistance (American Society for Testing and Materials [ASTM] D 1922 and 1709, respectively).*
    - *Seal article in first sheet with the openings twisted closed; all seams should be sealed with at least two wraps of duct tape and all other openings with at least two wraps of duct tape or two zip-ties to ensure closure of the wrap; disinfect the exterior surface with an appropriate (i.e., EPA-approved) agent.*
    - *Enclose wrapped article in second sheet and seal as previously described.*
    - *Package as per appropriate regulations, according to DOT HMRs or special permit.*
- *Disinfect the exterior surface of the package with an appropriate (i.e., EPA-approved) agent.*
- *Mark and label the package in accordance with DOT HMR, 49 CFR Part 172.301.*

# 8 WASTEWATER COLLECTION/CONTAINMENT/STORAGE

Large quantities of liquid waste and wastewater (e.g., from decontamination processes and from washing down equipment, materials, and personnel) should be managed by collection and treatment when possible to prevent release into a drainage system and ultimately into nearby rivers or other surface water. Preventing contaminated wastewater from running off into uncontaminated areas is an important consideration. The pathways that stormwater runoff take vary greatly from city to city. Vast networks of storm and sewer drainage systems should be understood to identify places prone to problems such as overflow and interference with proper wastewater management. Compliance with regulatory restrictions on wastewater can pose substantial challenges to the management of contaminated liquids. It is important to consult with the proper regulatory authorities during pre-incident planning activities and document information in the pre-incident plan so that wastewater can be managed properly.

This prior planning will also help to reduce the number of decisions that need to be made during the incident response, thereby freeing up the IC/UC to address other important issues associated with the overall response. The location of drains and other connections that would provide routes for materials to enter the environment must be identified and exits protected. All chemicals should be separated and contained according to standard environmental, health, and safety regulations.

A traditional wastewater treatment system may not be able to handle wastewater from a biological contamination incident. For example, many wastewater treatment facilities market their residual sludge for land application. The presence of a biological agent may preclude the facility from doing this, resulting in the creation of an additional waste stream requiring treatment and disposal. Because of this, a wastewater facility may decline to accept wastewater, even if they are capable of managing it, similar to solid waste and even hazardous waste facilities refusing to accept waste “tainted with the stigma” of being from a biological incident. Temporary storage of the wastewater may be necessary and could be addressed as part of pre-planning incident considerations.

## 8.1 Wastewater Treatment

The potential generation of large volumes of wastewater makes the wastewater treatment plant (WWTP) an important stakeholder that needs to be involved early during remediation when decontamination decisions are made (DHS and EPA, 2009).

The location of drains and other connections that would provide routes for materials to enter the environment must be identified, and appropriate measures to prevent unintended release to the environment should be taken. If a centralized containment or staging area is established, materials can be rinsed into a containment area where wastewater may need to be treated, then characterized, pumped, and properly disposed of. The need for treatment depends on local regulatory agencies, which should be contacted early in the remediation process (Raber et al., 2011).

For treatment of wastewater, treatment process operational parameters should be selected based on site specific conditions, including the bioagent involved. The parameters may vary as a function of pH or other water-quality factors and must be monitored to ensure effective treatment. Numerous substances in a wastewater matrix can interact with disinfectants; thus, disinfectant concentrations should be monitored during any wastewater decontamination process. A combination of treatment technologies may be necessary depending on the situation. For instance, physical removal techniques, such as filtration, flocculation, or settling may be necessary in addition to chemical treatment.

## 8.2 Aerosol Containment from Wastewater

Once decontamination wastewater is generated from a site, wastewater utilities may assume that some biological agent may have entered the sewer system, and appropriate measures should be taken for protection. Travel times within the collection system and detention times within the treatment plant can be estimated (although uncertainties in these estimates can vary) to determine when agents, if contained in the wastewater, may reach certain points in the collection system and different process units in the treatment plant. More information on protecting workers and the public from exposure to bioagents that have entered a storm/waste water system along with recent worker safety data, including suggestions and recommendations to increase worker safety is available (WERF, 2016).

# 9 BIOWASTE SAMPLING

Throughout the course of the response and recovery effort, sampling activities after a biological incident will be conducted for multiple purposes, including screening environmental sampling, characterization environmental sampling, sampling to support decontamination (both environmental sampling and decontamination verification sampling), clearance environmental sampling, and post-clearance environmental sampling (long-term monitoring. In addition, sampling would be done to support public health assessments and actions. Sampling following the initial identification of the contaminating agent is intended to determine the extent of contamination and the risk for responders and building occupants.

The development of a sampling plan can help to facilitate this process. As much information as possible should be obtained about the potential agent to be sampled, its physical characteristics, how it was released, the substrate it may be on, and its form, to ensure that the most appropriate sampling approach is used (EPA, 2015).

The sampling methods selected depend on the nature of the incident, the suspected agent, the analytical laboratory capabilities, and potential data uses. An analytical laboratory should be consulted regarding methods to collect samples from waste; it is outside the purview of this document to discuss specific methods regarding sampling.[4] Discussions with the data end-users as well as the laboratory will ensure that the most appropriate sampling method is selected and that the sampling event objectives are met.

Before sampling begins, the sampling team should closely coordinate all sampling requirements with the laboratory performing the analyses, usually the State Public Health Laboratory. For a wide-area biological incident, the available laboratory analytical capacity may be insufficient to provide for analysis of all of the samples that are desired to be analyzed. The state regulatory authorities will make the decision about frequency of waste sampling. Although it may be simple from a decision-making standpoint to require that every bag and barrel of waste be sampled, the same pools of laboratories will be analyzing the characterization and clearance samples from the response, and the burden of analyzing waste samples could potentially impact the remediation timeline.

In general, samples can be collected with surface wipes, vacuum filters, air filters, and liquid reservoirs and agar plates from air-impacted material, or from bulk solid or liquid materials that have been exposed. EPA's Environmental Response Laboratory Network (ERLN) has some limited capacity for analyzing biological environmental samples, and DHS' Integrated Consortium of Laboratory Networks (ICLN) will most likely manage surge capacity issues for individual networks (New York City DOHMH, 2015). An overall prioritization scheme will be integral to maintaining an efficient response. The CDC's Laboratory Response Network (LRN) typically does not accept environmental samples in media beyond what is normally used for surface or water sampling (e.g., wipes, sponge sticks, HEPA vacuum socks). The LRN would likely not take a bulk waste sample for analysis; therefore, large items (such as carpet and PPE) may need to be cut into smaller pieces.

Waste streams will need to be sampled to determine their characteristics and designations for use by receiving waste management facilities to meet their facility-specific WAC (EPA, 2015). Sampling and analysis of waste streams also provide additional information to guide Health and Safety plans for response workers, as well as waste management facility operators, waste haulers, and the general public (EPA, 2015).

[4] More information can be found at the following EPA link: www.epa.gov/sam (Accessed July 18, 2016).

For each sample location and sample type (air, surface, bulk, or water), planners should select a specific sampling and analysis method. Characterization planners could select from Selected Analytical Methods (SAMs) for environmental remediation and recovery following homeland security events (EPA, 2016d).

Planners should also seek guidance from authorized laboratories that will carry out sample analysis to coordinate sampling procedures and volumes (Raber et al., 2011).

The following recommendations are provided to maximize the efficiency of biocontaminated waste handling operations while minimizing exposure to the personnel involved in the process:

***Best practices to minimize exposure***

- *Correctly don and use/wear appropriate PPE for all steps;*
- *Change gloves between each sample to prevent cross-contamination;*
- *Do not overfill the sample containers;*
- *Place each sample in an unused, self-sealing sterile bag and properly label each bag, then seal the bag;*
- *Clean the outside of the sealed bag with amended sodium hypochlorite solution just prior to leaving the contaminated area;*
- *Place the cleaned sealed bag into another unused self-sealing bag;*
- *Place contaminated items in a biohazard bag; proceed to decontamination area;*
- *Place the sealed sample bag into an appropriate shipping container and transport samples at ambient temperature, unless specified otherwise, to the analytical laboratory; and*
- *Remove all PPE at the site perimeter and properly dispose.*

# 10 TRANSPORTATION AND DISPOSAL

Solid waste disposal is typically regulated by the solid waste management division of a state's environmental protection department. A waste disposal facility voluntarily accepts waste through contractual arrangement. It is generally easier to dispose of wastes at facilities within the same state in which the contamination is located, as opposed to another state. However, optimal disposal facilities for certain waste streams may not be present or may not be adequate in a particular state.

Municipal waste site operators may be reluctant to take material from a biological incident even after it has been decontaminated thus, Pre-Incident WMPs are essential. It is advisable during the pre-incident planning phase to identify multiple potential receiving facilities, and discuss the potential for waste coming to their facility from a biological incident, their WAC, and whether any permit modifications may be required. Having access to multiple facilities may become necessary during a large scale incident. Furthermore, a facility may decline to accept the waste, necessitating the need for backup facilities.

### *Transportation and Disposal for B. anthracis Incident*

*B. anthracis*-contaminated wastes (along with those of some other bioagents) are not regulated as hazardous wastes under Subtitle C of the Resource Conservation and Recovery Act (RCRA), but such contaminated wastes should be handled with caution because of the potential for exposure to an infectious agent. In some states and localities, such contaminated wastes are considered medical waste or infectious substances with special requirements for handling and disposal. Therefore, it is essential to contact the state or local regulatory agency early to determine what requirements apply and what treatment and disposal options are available. State authorities have the primary responsibility to regulate and oversee management of wastes that may be contaminated with an infectious agent such as *B. anthracis*. It is highly advisable to establish contact in advance of an incident or early in the remediation process with waste-disposal stakeholders, such as wastewater treatment plant operators and landfill, incinerator, and sterilization facilities.

The Pre-Incident WMP plan should reflect any state, local, or facility requirements (e.g., decontamination actions, post-decontamination sampling, and PPE for transportation and disposal facility workers) for disposal of decontaminated material as municipal waste. During the incident, the specific WMP should estimate types and amounts of wastes, transportation needs, and costs. It should also describe any clearance sampling to be done at disposal sites as well as long-term monitoring requirements, if necessary. The management of the remediation effort must characterize all wastes and manage each type according to applicable federal, state, and local regulations.

General criteria to consider prior to off-site transport of the waste should include identification of:

- Source of the waste;
- Waste streams;
- Any restricted materials or hazardous waste;
- Volume reduction methods and needs;
- Waste form (solid, liquid, chemical compatibility);
- Types of external containers (drums, bags, boxes) and associated materials and thickness;
- Primary containers (plastic film bags, lined boxes);

- Weight and dimensions of the waste;
- Handling, transporting, and tracking requirements; and
- WAC (New York City DOHMH, 2015).

The following subsections contain recommendations to maximize the efficiency of biocontaminated waste handling operations while minimizing exposure to the personnel involved in the process.

## 10.1 Handling/Offloading of Waste at Waste Management Facilities

Hazardous waste management facilities should receive hazardous wastes for treatment, storage or disposal as outlined below (EPA, 2016a):

- Treatment – Using various processes such as incineration or oxidation to alter the character or composition of hazardous wastes. Some treatment processes enable waste to be recovered and reused in manufacturing settings, while other treatment processes dramatically reduce the amount of hazardous waste.
- Storage – Temporarily holding hazardous wastes until they are treated or disposed. Hazardous waste is commonly stored prior to treatment or disposal and must be stored in containers, tanks, containment buildings, drip pads, waste piles, or surface impoundments that comply with the RCRA regulations. The regulatory requirements for these types of storage units are found in title 40 CFR Part 264 for permitted facilities and Part 265 for interim status facilities.
- Disposal – Permanently containing hazardous wastes. The most common type of disposal facility is a landfill, where hazardous wastes are disposed of in carefully constructed units designed to protect groundwater and surface water resources.

Prior to shipment of any waste, waste streams will need to be sampled (discussed in Section 9) to determine their characteristics and designations for use by receiving waste management facilities. This characterization is important because the owners/operators of these waste management facilities are permitted by state environmental agencies with facility-specific WAC. Waste generators must complete facility-specific waste profiles prior to the facility's acceptance of the waste. This information should be identified in the Pre-Incident WMP.

***Best practices to minimize exposure***

- *An off-site facility should possess:*
    - *Space for further segregation or processing;*
    - *Designated temporary storage that provides protection and security against weather, pest infestation, and trespasser interference;*
    - *Suitable processing capacity;*
    - *Appropriate handling and processing equipment;*
    - *Safety equipment and protocols;*
    - *Adequately trained and skilled personnel;*
    - *Procedures for contingencies and emergency shutdowns; and*
    - *A confirmed final disposal site (critical for tracking the waste and ensuring final disposal of the treated residue).*

*B. anthracis* is a select agent defined under CDC's Select Agent Regulations (9 CFR 121 and 42 CFR 73); therefore, before transporting *B. anthracis*-contaminated waste to an off-site treatment facility, CDC Select Agent Program officials need to be contacted to determine special handling and transportation requirements that apply. It should be noted that Select Agent Regulations do not apply to waste that is to be incinerated, autoclaved or otherwise treated for ultimate disposal; these regulations apply only if intentionally recovering the agent from the waste.

After transport, the containers can be stored on site in loading docks or designated storage areas, but the wastes must remain in the original containers and the containers may not be opened by the exempt transfer facility. When wastes remain in the containers that they were shipped in and have not reached the final destination, the wastes continue to be subject to DOT HMRs. Once waste has arrived at its destination or is handled on site, the wastes are no longer in transit nor subject to DOT's regulations but are instead subject to hazardous waste laws. Wastes may remain on the transport vehicle for up to 10 days after arrival at a facility but, once off-loaded from the vehicle, the waste must be moved directly to an authorized waste management unit. No additional handling of the waste is allowed, meaning no mixing, pumping, altering of packaging or handling, of wastes that may lead to a discharge can take place at an exempt transfer facility. The containers must remain intact and cannot be opened at exempt transfer facilities. If a facility bulks, packages or containerizes hazardous wastes or handles wastes in any manner other than transferring a packaged or containerized waste from one vehicle to another, a permit will be required. When wastes arrive at the designated facility, it constitutes completion of the transportation phase and the facility operator must acknowledge receipt of the wastes by signing a manifest. (California Environmental Protection Agency (CalEPA) Department of Toxic Control Substances, 2006)

***Best practices to minimize exposure***

- *Do not stack or compress waste in a way that may compromise package integrity when loading onto vehicles or during transport; improper stacking can also lead to falling/spillage;*
- *After loading and prior to transportation, the transporter must perform an external visual inspection of the transport vehicle to determine that it is closed and free of leakage;*
- *While in transportation, the doors on the motor vehicle or shipping container being used to transport the material must be closed and locked except when an outer package is being loaded or unloaded into the vehicle.*
- *Under the DOT's HMRs, the transporter must respond to any release from a package that occurs during transportation..*
- *Each motor vehicle used must be decontaminated in accordance with applicable federal, state and local laws.*

Permits for facilities approved to accept the waste should cover the types and quantities of waste, technical requirements, safety and security precautions, operational requirements (e.g., ability to inactivate *B. anthracis* spores) prior to treatment, and disposal of the waste. A permitted facility would need to demonstrate that it can safely manage this waste at all times, and verification of these conditions should be provided to the appropriate authority for written approval prior to transporting the waste to the treatment facility. Many waste management facilities may not have these types of biological wastes identified within their operating permits and would therefore require permit modification. Identifying this information in Pre-Incident WMPs can prevent the time required for permitting state agencies to review and approve these modifications, thereby reducing the overall time and cost of the response and recovery from these types of incidents.

Items that contain hazardous components at environmentally significant levels will require special handling, even after the removal of all viable *B. anthracis* spores and regulations may vary from state to state, and consider DOT regulations when applicable. Small waste items that are hazardous, by DOT definition, must be packaged and transported pursuant to DOT HMR 49 CFR Parts 100–185. Sterilized small and large hazardous waste items that are normally recycled and that contain interstitial spaces should not be recycled but managed as hazardous waste. Large DOT-regulated items may require placement in DOT-approved bulk containers.

If the contaminated waste cannot be packaged and transported in accordance with the HMR, the waste transporter may apply for a special permit.

For a *B. anthracis* incident, once laboratory analysis verifies the reduction or absence of viable spores, the treated waste may be managed as follows:

- Waste that still has viable spores must be packaged, marked, and labeled in accordance with appropriate DOT HMR (CFR 49 Parts 100 To 185) and managed and subsequently treated and disposed of in accordance with state requirements at an appropriate treatment facility. OSHA Bloodborne Pathogens (BBP) standard (29 CFR 1910.1030) packaging requirements may also apply when the material being packaged for transport contains a BBP or other potential infectious material under the standard.
- Waste that meets the clearance criteria may potentially be discharged to a wastewater treatment facility (subject to considerations in the discussion above) or may be managed at an authorized solid waste landfill, recycler, or municipal waste combustor. Treated vehicles may be managed at an authorized vehicle dismantler or returned to the owner. Waste must be transported by a transporter permitted to haul these wastes.
- Landfills have traditionally been the final disposal option for solid waste and may be available for managing the material created in the event of a biological threat agent terrorist attack.

# 11 CLEARANCE AND RE-OCCUPATION

Clearance is undertaken to verify the efficacy of decontamination, provide the best possible scientific evidence that a residual biological agent is no longer present at a level that poses unacceptable risk to human health, and determine whether it is appropriate to release an outdoor area, semi-enclosed structure, indoor facility, or water system for re-occupancy or reuse (EPA and CDC, 2012). Establishing clearance goals, along with a strategy for meeting those goals, is an early and essential step in the overall remediation process. Clearance goals inform all aspects of the remediation process, from characterization to decontamination through to clearance. The clearance process itself includes the following major components:

1. Clearance sampling and analysis, potentially including environmental surface sampling, water sampling, and air sampling;
2. Review of all relevant information in light of the clearance goals, including review of environmental sampling data, data on any source-reduction activities, and data from monitoring the decontamination processes, including any biological indicators used in indoor fumigation verification; and
3. The determination of whether to release a given area, facility, or water/wastewater system for restoration or re-occupancy (New York City DOHMH, 2015).

### *Clearance for B. anthracis incident*

For a *B. anthracis* incident, regardless of the type of environment contaminated, the EPA and CDC recommend that “no detection of viable spores” is the best practicable clearance goal (EPA and CDC, 2012). There may be viable residual spores present below the current sampling and analytical detection limits. Currently, culture-based analysis is the best widely available method for determining the presence of viable *B. anthracis* spores. Appropriate environmental sampling and decontamination strategies should be selected to achieve the clearance goal. The clearance strategy may be adjusted based on the incident; the IC/UC will make the final decisions on remediation approaches (EPA and CDC, 2012).

# 12 CONCLUSION

The aim of this document is to inform readers on best practices for handling waste that contains (or contained) biowaste after a biological incident. Waste will originate from all phases of remediation and includes contaminated indoor and outdoor materials; waste generated from personnel and victims; vehicle and equipment decontamination waste, and waste generated from packaging and transporting contaminated materials. These best practices are applicable to a variety of biological agents, and uses *B. anthracis* as a focused example when information is available.

As discussed throughout this document, pre-incident waste management planning is essential. By considering waste management in advance, it becomes much easier to tailor a Pre-Incident WMP to a specific site or biological incident rather than waiting to make difficult decisions after the incident occurs or in the middle of the emergency. In recent years, large incidents involving biological/infectious agents have generated numerous lessons learned that could be applied to wide area biological incidents and incorporated into pre-incident waste management planning by federal, state and local emergency planners and managers. As part of a Pre-Incident WMP, training should be conducted and lessons learned from the exercises should be incorporated back into the plans to maintain constant improvement and readiness. EPA's ORCR has developed a pre-incident waste management planning process for creating, updating, and implementing a Pre-Incident WMP for managing waste. Their four-step process is designed to help communities prepare for waste management needs of an incident, regardless of the hazard. A pre-incident plan template outline is provided in Table A-1 of Appendix A.

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# APPENDIX A

# APPENDIX A: DEVELOPMENT OF THE PRE-INCIDENT WASTE MANAGEMENT PLAN (WMP)

This Appendix describes the recommended pre-incident waste management planning process for creating, updating, and implementing a Pre-Incident WMP for managing biological wastes. As depicted in Figure 3 of Section 4, the waste management planning process can be divided into four main steps:

1) Conducting pre-planning activities;
2) Developing a comprehensive Pre-Incident WMP for all hazards;
3) Keeping the WMP updated by regularly reviewing, maintaining, exercising, and training with the WMP; and
4) Implementing the WMP during an incident.

The components of these steps are described in the following sections. A pre-incident plan template outline is provided in Table A-1.

## Step 1: Pre-Planning Activities

1) Prioritize plan development:
    - o Conduct a hazard assessment, looking at possible scenarios and hazards, their likelihood, and the wastes and volumes generated.
    - o Consider whether you want a single plan that addresses all hazards (recommended) or separate, scenario-specific plans.
2) Identify and engage individuals who should be involved in the planning process for possible scenarios or scenario-specific plans, as appropriate;
3) Identify and review national, regional, and local plans, any industry-specific plans, and mutual aid agreements (MAAs), if appropriate:
    - o Include plans of bordering localities, if appropriate.
4) Identify opportunities for hazard mitigation to enhance community resilience (e.g., retrofit PCB transformers);
5) Determine legal and regulatory waste management requirements, issues, and considerations;
6) Determine FEMA cost reimbursement requirements, if appropriate; and
7) Identify unique local circumstances/issues (e.g., union issues, geography).

## Step 2: Pre-Incident WMP

1) Use available tools to aid in the plan development;
2) Consult with the individuals identified in Step 1 when developing the plan;
3) Consult with owners and operators of waste management facilities, haulers, and other entities as they are identified while developing the plan; and
4) Identify options for reuse and recycling for different wastes and consult with facilities about establishing acceptance criteria for those wastes.

## Step 3: WMP Review, Maintenance, Exercise, and Training

1) Meet with stakeholders to review and update the Pre-Incident WMP regularly;
2) Schedule waste management-related exercises;
3) Develop a training plan to address training needs (for staff and equipment); and
4) Incorporate any waste management lessons learned, after action reports, and improvement plans into the Pre-Incident WMP.

## Step 4: Incident-Specific WMP

1) Identify the Pre-Incident WMP that best aligns to the specific incident;
2) Identify waste management-related policy or implementation issues that require resolution;
3) Create the incident-specific WMP based on the Pre-Incident WMP:
    - Include the incident's situational overview, generated waste types and quantities, locations of waste, an exit strategy, and health and safety requirements and update other sections of the plan with real world numbers, as appropriate.
4) Present the incident-specific plan to the appropriate IC staff;
5) Notify waste management facilities of anticipated needs and exercise contract support where necessary;
6) Implement the community communications/outreach plan;
7) Identify sampling requirements and notify laboratories of anticipated analysis needs;
8) Conduct waste management oversight activities (e.g., site visits and inspections of, as well as environmental monitoring at, waste management sites, contractors), as necessary; and
9) Implement the cradle-to-grave waste and material tracking and reporting system.

The outline in Table A-1 describes the "table of contents" of a typical Pre-Incident 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. This column also provides links to tools and resources that may aid in the development of the plan, as well as tips on adapting the 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 the development of a Pre-Incident WMP. The final organization and contents of a WMP are entirely up to emergency managers and planners. Keep in mind that the National Response Framework (NRF) will guide a response through 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. Text in red, indicates information that will be replaced or updated at the time of the incident. However, scenario- and agent-specific information also should 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.

## Table A-1. Suggested Pre-Incident All Hazards Waste Management Plan Outline

| Plan Contents: | Considerations: |
|---|---|
| I. Plan Overview<br>1. Scope<br>*Scenario and entity covered*<br>2. Planning assumptions<br>3. List of officials who should be notified in the case of an incident<br>4. Regulatory requirements<br>5. Record of plan reviews and updates<br>*(e.g., adding new and updating current facilities)* | This section will be replaced at time of incident with the Situational Overview.<br><br>Scenarios may be based on National Planning Scenarios and/or site-/community-specific threats or hazards.<br><br>Include relevant federal, state, tribal, local, and territorial regulatory and legal requirements that impact waste management, as well as the impact that an emergency declaration might have on 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. |
| II. Materials and Waste Streams<br>1. List of anticipated waste streams<br>2. Description of each waste stream<br>*Include regulatory status (federal and state), associated hazards if any, agent-specific (e.g., biological) information, fact sheets if any, and packaging, labeling, handling, and transportation requirements, as well as identify decontamination and reuse, recycling, treatment, and disposal options appropriate to that waste stream* | This section will be replaced at time of incident with the actual waste streams generated by the incident. |
| III. Waste Quantities<br>1. Forecast quantity of each type of anticipated waste<br>2. Method for estimating actual waste quantities during/after incident<br>*(e.g., GIS, windshield assessment)* | This section will be replaced at time of incident with waste estimates based on the specifics of the incident.<br><br>**Recommended tools:**<br>Incident Waste Decision Support Tool (I-WASTE DST) Accessed May 20, 2016, at http://www2.ergweb.com/bdrtool/login.asp<br><br>Hazus (FEMA's tool for estimating potential losses from disasters) Accessed May 20, 2016, at http://www.fema.gov/hazus |
| IV. Waste Characterization Sampling and Analysis<br>*(for each waste stream)*<br>1. Sampling | Two different types of sampling may be needed to meet WAC at waste management facilities and to allay community concerns: 1) sampling to |

| Plan Contents: | Considerations: |
|---|---|
| *Estimate number of samples, identify type of analysis needed for each waste/material type, and address health and safety issues, such as appropriate PPE for sampling activities*<br>2. Analysis<br>*Identify laboratories that can conduct the analyses, as well as methodologies for the analyses, what items are needed for sampling (e.g., swabs, sample bottles), sampling methodologies (e.g., composite sampling procedures), and the required techniques*<br>3. Quality assurance<br>*Identify methods that will be used to ensure quality assurance* | determine federal, state, or local regulatory status, and 2) sampling to ensure that waste/materials have been effectively decontaminated.<br><br>Environmental Justice and other community concerns may make it advisable to conduct testing even when it is not regulatorily required or conduct additional sampling and analysis to ensure transparency. As this additional testing may be cost-prohibitive, an alternative may be managing all waste as hazardous waste under RCRA. The relative costs/benefits should be evaluated.<br><br>Laboratory selection considerations include capacity, access, cost, time needed to produce results, and anticipated community concerns. |
| V. Waste Management Strategies/Options<br>1. General principles<br>*by activity*<br>a. Minimization (actions to minimize waste generation, toxicity, physical size)<br>b. Collection (procedures; health and safety requirements)<br>c. Segregation (procedures)<br>d. Decontamination (people, equipment, waste/materials; health and safety requirements)<br>e. Accumulation/Storage (site location selection criteria; documentation; health and safety requirements)<br>2. Pre-selected waste management sites<br>*Site-specific information, by category*<br>a. Waste staging and storage (temporary and permanent) locations<br>b. Equipment staging and storage (temporary and permanent) locations<br>c. Decontamination stations | 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).<br><br>Relevant regulatory and other legal requirements should be considered.<br><br>Reuse and recycling are preferred options; consider adding a list of possible materials that can be reused or recycled.<br><br>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.<br><br>Whether specifying sites/locations or developing guidelines, consider:<br>• Benefits of on-site vs. off-site management;<br>• Speed with which waste needs to be managed;<br>• Facility requirements and capacity;<br>• Permitting procedures;<br>• Cost of various options;<br>• Community/Environmental Justice concerns;<br>• Site security;<br>• Resources needed, including private sources of equipment; |

| Plan Contents: | Considerations: |
|---|---|
| | • FEMA cost reimbursement requirements;<br>• Proximity to anticipated waste generation points;<br>• Ease of access;<br>• Ease of containment of wastes/materials;<br>• Ownership of sites; and<br>• Proximity to sensitive/protected areas.<br><br>Consider possible need for long-term groundwater, air, and other environmental monitoring at on-site burial sites and other waste management facilities or sites. |
| VI. Waste Management Facilities<br>1. Anticipated types of waste management facilities needed<br>*Identify all facility types needed to manage anticipated waste streams and quantities*<br>2. Specific facilities identified<br>*Detailed information on each potential site, to aid in selection at time of 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, WAC, financial status, distance from anticipated waste generation points, cost, community concerns* | 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.<br><br>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.<br><br>State permission may be required.<br><br>Communicating with facilities before an incident occurs can help to determine the facilities' WAC, which may be more stringent than what is legally required (e.g., to help determine sampling and analysis needs, size requirements). |
| VII. Transportation<br>1. Logistical options<br>2. Routes (including maps)<br>3. Hauler information<br>*Detailed information on each potential hauler to aid in selection at time of incident, including some or all 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* | Consider all modes of transportation, including vessel and rail, as well as possible differences in restrictions for interstate highways and local roads. Keep in mind packaging, labeling, and transportation requirements (e.g., USDOT, state).<br><br>Zoning restrictions may be an issue, particularly for large vehicles.<br><br>State permission may be required.<br><br>Highway weight restrictions may vary based on time of year.<br><br>Proximity to transportation is an important consideration when selecting a waste management site (e.g., whether heavy equipment can access the site to load the large quantities of |

| Plan Contents: | Considerations: |
|---|---|
| | waste onto barges, railway), as well as proximity to waste management facilities.<br><br>Consider including a pre-scripted outline or fact sheet of hauler responsibilities, including health and safety requirements.<br><br>Drivers may be considered emergency workers and subject to applicable exposure limits. |
| VIII. Waste and Material Tracking and Reporting System<br>1. General principles<br>2. Databases or other tracking software to be used<br>3. Waste tracking report templates<br>*Indicate information to be tracked* | Tracking the waste from cradle to grave helps increase transparency and aids in allaying community concerns. Keep in mind security concerns regarding sensitive information.<br><br>Haulers may use different units of measurement, which should be adjusted as needed to maintain consistency. |
| IX. Community Communications/Outreach Plan<br>1. Contact information for key stakeholder groups *(e.g., community groups, government officials)*<br>2. Pre-scripted information for waste management activities involving the public *(e.g., fact sheets, public service announcements (PSAs), frequently asked questions)*<br>3. Information for a response website | Past incidents show that communities express more concern with wastes from homeland security incidents than they do with wastes not tied to such incidents; community concerns have driven waste management decisions in the past (perceived risk vs. actual risk).<br><br>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.<br><br>During an actual incident, public outreach takes place within the Incident Command System.<br><br>Also consider the use of social media and the need for interpreters/translators. |
| X. Health and Safety for Waste Management Activities<br>*Ensure that the overall incident HASP includes information related to waste management activities.* | While a general HASP for the incident will be developed, specific waste management activities may require additional guidance and should be addressed. |

| Plan Contents: | Considerations: |
|---|---|
| XI. Resource Summary<br>*Gathered from all previous sections*<br>1. Resource needs<br>*Equipment, staff, other*<br>2. Resource sources<br>a. Mutual Aid Agreements (MAAs)<br>b. Pre-negotiated contracts<br>3. Specialized Technical Assistance Contacts<br>4. Contracting<br>a. Emergency procurement procedures<br>b. Contract oversight plan<br>5. Cost Accounting/Financial Management<br>6. FEMA Cost Reimbursement Forms and Guidance | Resources may be available in-house, from contracts, or through agreements.<br><br>Contractor qualification requirements should be considered. |
| XI. Oversight Activities and Exit Strategy<br>*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, sampling and analysis of waste streams), the transition of roles and responsibilities, and the frequency of each activity.* | This section will be developed and added at the time of an incident.<br>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). |

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