Decision Support Tool for the Management of Debris from Homeland Security Incidents

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SUMMARY: Unique challenges exist for the handling, transport, and disposal of debris resulting from homeland security incidents, disasters or other national emergencies. Safe and timely disposal of disaster debris is critical to helping restore a community or region and prevent further contamination or spread of disease. The U.S. EPA's Office of Research and Development is conducting research to develop a suite of decision support tools that provide quick and easy access to information needed for making decisions associated with handling, transport, and diposal of disaster debris. The DSTs provide location-specific information to identify specific facilities and contacts for making debris management decisions. The DSTs provide references to technical information, regulations, and other information to provide decision makers with assistance in disposal decisions that are important for the protection of public health, first responders, and the environment. This research is being conducted in support of the U.S. Department of Homeland Security and in partnership with other U.S. government agencies, EPA program offices, industry, and state and local emergency reponse programs.

1. INTRODUCTION

Pollution incidents of national significance can be caused by industrial accidents; natural disasters such as hurricanes, floods, and earthquakes, terrorist attacks; weapons of mass destruction; and disease outbreaks impacting the safety of the U.S. food supply. These incidents require an integrated response from federal, state, and local government. The Department of Homeland Security (DHS) has updated the National Response Plan (NRP) and the National Incident Management System for responding to Homeland Security incidents of national significance. Within the NRP, the DHS has identified 15 National Planning Scenarios that every federal, state and local emergency response agency is to create emergency plans for. Each of these 15 scenarios involves decontamination and disposal of contaminated material. As a result, disposal decision making has become more complex and emerging issues have surfaced that make it critical that emergency response plans have tools available to assist decision makers in effectively managing debris from incidents of national significance so that there is no further threat to human health and the environment. Ensuring safe, cost effective, and timely disposal of waste debris is critical in minimizing the impact on human health and the environment. The

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National Science and Technology Council estimates that disasters cost an average of $52 billion per year in terms of lives lost, property destroyed, disruption of commerce, and emergency response (NSTC, 2005). The Solid Waste Association of North America captured key lessons learned from the aftermath of the Hurricane Katrina response that are important to address in current emergency response plans (SWANA, 2005). Current regulations and waste management plans and practices need to be reassessed to ensure that they are adequate to deal with the unique threats and challenges confronting Homeland Security in the 21st Century.

There are a wide range of potential events that can lead to large volumes of waste debris or potentially difficult-to-manage waste. Traditional hazards include wildland and urban fires, floods, oil spills, transportation accidents, earthquakes, hurricanes, tornadoes, and pandemics. More difficult challenges are faced from either deliberate or accidental contamination with industrial chemicals, biological/chemical warfare agents, or radiological dispersal devices (i.e., dirty bombs). Foreign animal disease outbreaks and emerging infectious diseases also pose disposal challenges and occur worldwide. The goal is to prevent further outbreaks or minimize further spread of the disease. The foot- and- mouth disease outbreak in the United Kingdom in 2001, chronic wasting disease in North America, and the avian influenza outbreaks currently occurring in Asia, resulted in a large volume of animal carcasses to dispose of and highlighted some of the uncertainties on how this type of disposal could be managed.

In 2002, the National Homeland Security Research Center (NHSRC) of the U.S. Environmental Protection Agency was created. As part of the NHSRC research effort, guidance and tools are being developed to help respond to incidents of national significance. A part of this program specifically addresses waste disposal issues resulting from such incidents. This waste disposal research program is coordinated through the Department of Homeland Security, other federal agencies, and with state and local government officials, industry, and international research partners. One of the major outputs from this research is the development of a suite of Disaster Debris Management and Disposal Decision Support Tools (DDMD-DSTs). (Lemieux, 2004) The objective for the development of these tools is to provide assistance to (1) emergency responders who have to determine the most appropriate options for handling, transport, and disposal of disaster debris; (2) state and local agencies who have responsibility for facility permits and ensuring compliance with applicable regulations; and (3) waste management and water utility industries that provide safe disposal of these wastes without affecting the operation of their facilities, violating any applicable regulations, and providing safe working conditions for their employees.

It is important to note that this tool is not intended to override existing regulatory or legal requirements that apply to the disposal of materials. Rather it provides a starting point for cleanup activities. Final disposal decisions can only be made after contacting the appropriate persons at state and regional regulatory offices and coordinating with the disposal site. The DDMD-DSTs also provide quick reference to technical information, regulations, and guidance to assure safe and efficient removal, transport, and disposal of incident debris.

2. DESIGN PHILOSOPHY AND TECHNICAL APPROACH

The objective of the DDMD-DSTs is to help reduce restoration time by providing a stepwise approach in the decision making process for disaster debris management. Guidance is provided that is specific to the types of materials and contaminants involved. This guidance is also specific for the unique issues or challenges faced with ensuring public and worker safety throughout the packaging, transportation, treatment, and disposal process. Rather than providing massive quantities of information to the user, the tool tries to distill information while maintaining links to more detailed information if desired. The tool is web-based to link the user to more detailed sources of data and information. Using a web-based platform also facilitates

more frequent updates to guidance, facility information, and points of contact. DSTs are available to address:

- Building decontamination residue disposal;
- Decontamination wastewater disposal;
- Water system materials disposal;
- Natural disaster debris disposal; and
- Agricultural biomass disposal.

Waste streams that are covered include aqueous solutions and building debris from decontamination of buildings, including furniture, ceiling tiles, wall hangings, and carpeting. With hurricane events, there can be significant quantities of waste that are contaminated from damaged chemical and industrial facilities, mold, and other pollutants. Cleanup of contaminated water treatment and distribution systems may involve the disposal of pumps, filters, piping, and other equipment. The waste also includes personal protective equipment from the cleanup crews, which may be contaminated with residual agents at varying and possibly unknown levels. For agricultural biomass and animal carcass disposal, there can be other unique issues regarding the urgency in response time and need to minimize further impacts.

Figure 1 provides a screenshot of the login page. The tool is password-protected and enables users to create a decision scenario and save it for later reference or revision. Each user has a unique username and password based on three different user groups: (1) EPA and other federal agencies; (2) State and local agencies; and (3) industry, trade associations, or other users. The user can share scenarios that are created or limit access. To create a scenario, a user must specify the incident location and the type and characteristics of waste material. The user follows a stepwise approach to determine the quantity and inventory of waste material, potential disposal facilities, and transport options. For example, back-of-the-envelope waste quantity estimators are available for determining building residue from the decontamination of hotels, offices, schools, shopping centers, theaters, and residences. Links to guidance and training modules for the disposal of agricultural biomass and animal carcasses are also available through the U.S. Department of Agriculture.

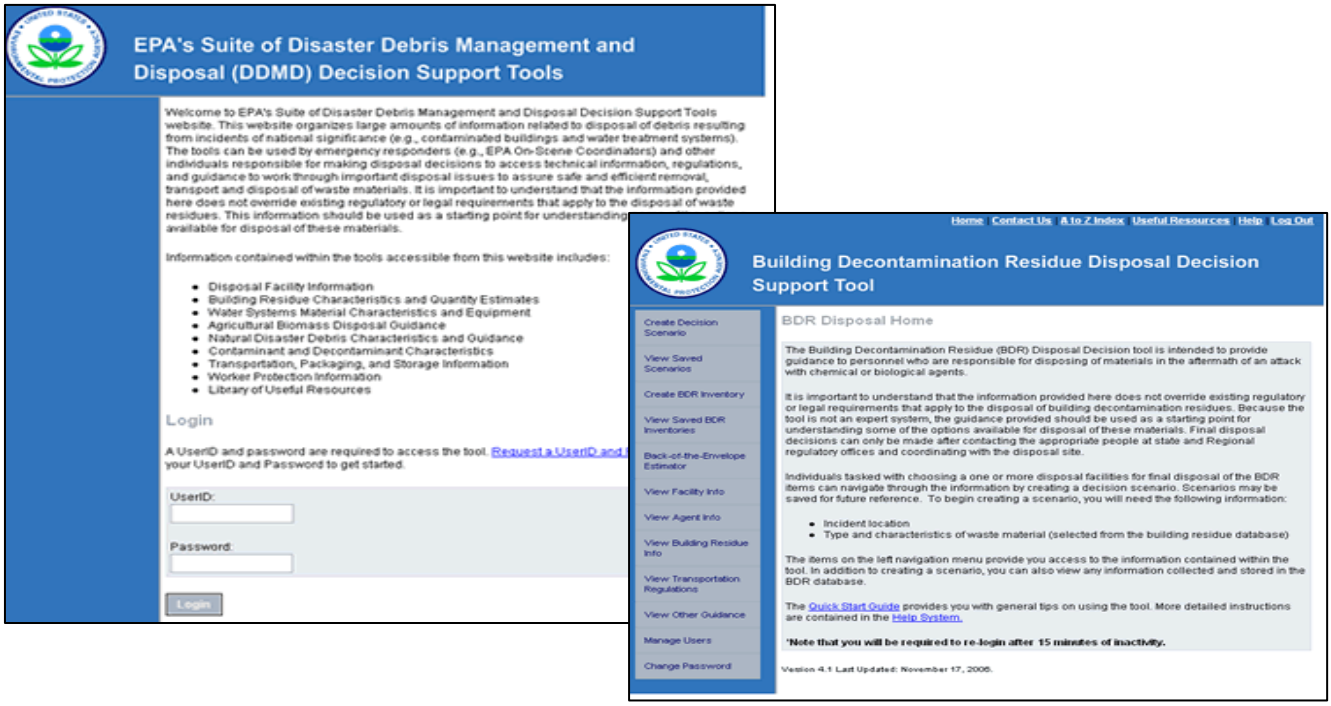

Figure 1. Screenshots from the Disaster Debris Management and Disposal Tool

The information that is contained within or accessible through the DSTs includes:

- Disposal facility information with a database of incinerators, landfills (hazardous waste, municipal solid waste, and construction/demolition debris), wastewater treatment facilities, electric arc furnaces, wood-fired boilers, aluminum and copper recylers, and medical waste autoclaves;
- Building residue characteristics and quantity estimates and guidance and/or regulations for worker protective equipment, building decontamination residue removal, packaging and shipment;
- Water systems materials characteristics and equipment and guidance for disposal of water treatment facility residues;
- Agricultural biomass disposal (including animal carcass disposal) guidance;
- Natural disaster debris characteristics and guidance;
- Contaminant and decontaminant characteristics;
- Worker protection information; and
- Library of resources to assist in the decision making process.

3. OVERVIEW OF DSTS FOR DISASTER DEBRIS MANAGEMENT

3.1 DST for Disposal of Building Decontamination Residue

The DST for disposal of decontaminated building debris is the first one to be developed with work beginning in 2003. This DST was developed in response to the cleanup of buildings from anthrax attacks on government and news media buildings in 2001. The DST was developed by working closely with stakeholders who had first hand experience in dealing with the aftermath of September 11th and anthrax attacks. Industry and others who have expertise or concerns associated with developing appropriate guidance for disposal of incident debris were also involved in the DST development. (U.S. EPA, 2003)

The DST can help an end user in planning, as well as responding to a potential event. For most expected applications, the initial response and decontamination activities will have occurred prior to use of the DSTs to determine disposal options. It can also be used in helping to plan decontamination to look at scenarios based upon the selection of different decontamination technologies to estimate waste quantity and characteristics. Porous materials are more difficult to decontaminate and it is difficult to guarantee that there is no remaining contaminant. When developing waste categories, materials are classified taking into account the ability to ensure that the material has been decontaminated. Waste classification categories include hazardous waste, municipal solid waste, constuction and demolition waste, and special waste. The DST provides assistance or guidance to the address the following:

- Estimating waste quantities and debris characteristics to generate waste profile information;
- Identifying available disposal options and capacity for the different categories of waste on a geographical basis, including contact information for the range of potential disposal facilities. [The range of disposal facility types include incinerators, landfills (hazardous waste, municipal, construction and demolition debris), autoclaves, and wood-fired boilers];
- On-site preprocessing and packaging of waste materials to make the material more amenable for disposal in a given facility;
- Guidance for transporting the waste materials;
- Guidance to minimize risk to workers handling the waste materials, to the disposal facility workers, and to people along the transportation route to the disposal facility, and to minimize potential for contaminating the disposal facility; and
- Methodology for calculating initial estimates of potential disposal costs.

A summary screen from an example scenario and a screenshot for the back-of-the-envelope estimator is provided in Figure 2. The DST provides information on potential disposal facilities including contact information and links to operating permits. The DST also provides links to relevant packaging regulations and guidance on performance requirements for containers. Finally, the DST has a list of possible suppliers of hazardous material transport containers.

Once a potential disposal facility has been located, maximum container size requirements for that facility can be combined with the waste inventory database to estimate whether additional size reduction will need to be performed prior to shipment to the disposal facility. A list of potential methods for size reduction is presented, along with potential suppliers for the size reduction equipment.

The DST for decontaminated building debris also contains external links to the various transportation regulations as well as transportation companies suitable to haul the materials to the disposal facility. The DST has an external link to "SafeStat", where potential haulers can be evaluated for their safety records. Finally, the DST provides a link to the U.S. Department of Energy's Transportation Routing Analysis Geographic Information System (TRAGIS) tool (U.S. DOE, 2006). This is a Geographical Information Systems based tool that allows appropriate transportation routes to be created.

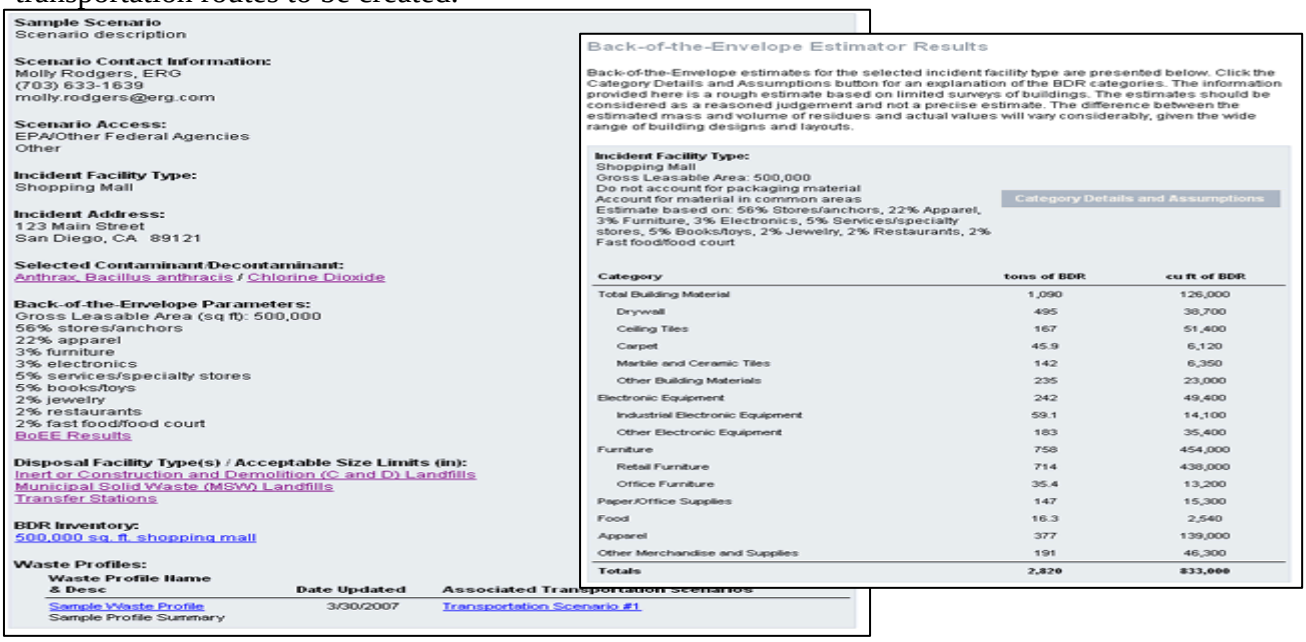

Figure 2. Screenshot of Summary and the Back-of-the-Envelope Calculator from an Example Scenario in the Building Decontamination Residue DST

3.2 Decontamination wastewater disposal

The Decontamination Wastewater Disposal DST provides guidance on the handling, transport, and disposal of wastewater generated during the decontamination of buildings or materials with chemical or biological contaminants. Information provided includes potential disposal facilities, contaminant/decontaminant information including decontaminant treatment options, and applicable hazardous materials transportation regulations for liquid waste. The tool does not provide methodology for estimating the quantity of wastewater because of the wide variability based on the nature of the event.

3.3 Water system materials disposal

Drinking water treatment plants, water supply networks, the water using community, and wastewater treatment plants are linked together as an integrated system. In the event that chemical or biological contamination is introduced at some point in this system, significant cleanup may be required. Within this module of the debris management tool, four separate

DSTs have been developed to address potential contamination. The different DSTs are identified in the home page for this module (Figure 3). For developing a scenario, the incident location and system characteristics are specified. For the disposal of debris from the

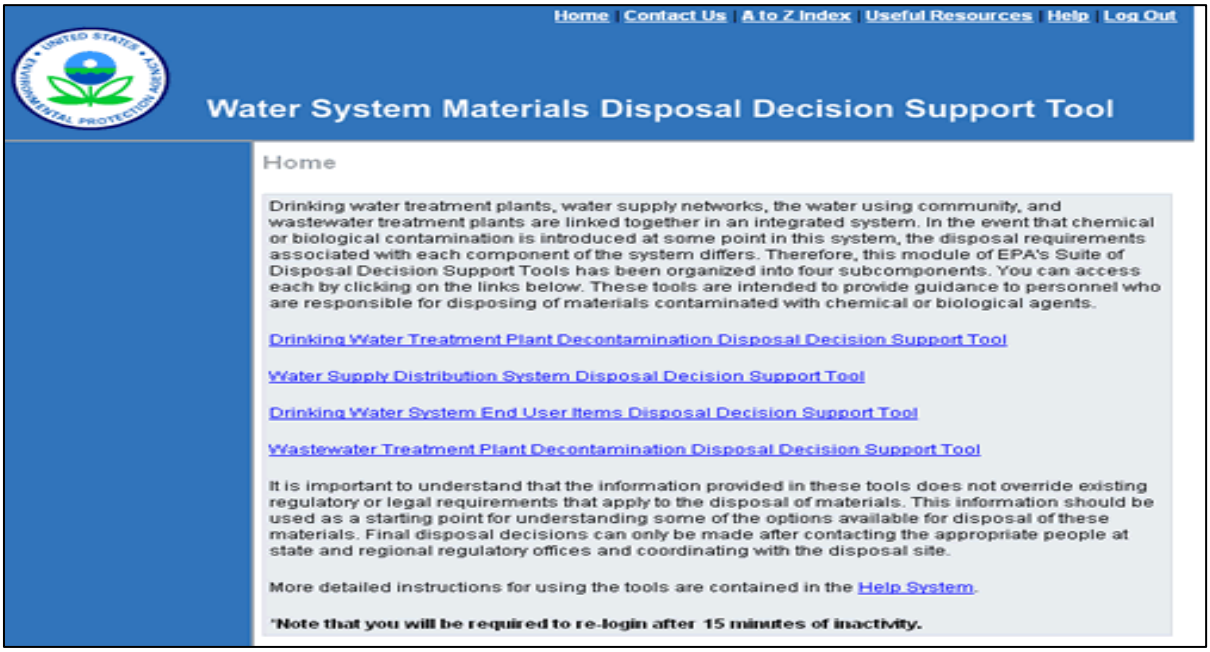

Figure 3. Screen shot of home page for Water System Materials Disposal DST

decontamination of a drinking water treatment plant, the user must specify the throughput for each unit operation and provide characterics of the primary and secondary treatment and type, solids management, filration operations, disinfectant, and any other treatment in use. This enables the user to calculate and inventory debris to be managed. The DST also provides access to guidance on handling, transport, and available disposal facilities.

The second DST within the water systems module is for a water supply distribution system. In the event of biological or chemical contamination of a water supply distribution system, various parts (e.g., pipes, pumps, valves, hydrants etc.) of the system may be affected. When underground pipes need to be disposed of, their removal will disturb the surrounding soil and there may be subsequent ex-filtration causing contamination of the soil. The DST allows users to account for the quantity of disturbed soil that may require removal based on the pipe diameter and length for each type of pipe specified.

The third DST is used to assist in the cleanup of end user items based on the community size and distribution (i.e., urban, suburbs, rural). Factors were developed for different geographical regions based on a Residential Energy Consumption Survey conducted in 2001 by the U.S. Department of Energy. In addition, supplemental data are provided for 14 U.S. cities. This information provides the end user with an estimate of the quantity and inventory of material to be managed. Guidance is also provided to characterize debris from water use by institutional and commercial sectors, using factors based on the American Water Works Association Research Foundation's Report, Commercial and Institutional End Uses of Water (2000). As with the other DSTs, guidance is provided on handling, transportation, and potential disposal facilities.

The final DST within the water systems module is for wastewater treatment plants. Similar to the other tools, the user creates a scenario providing specifics on the incident location and facility information. The user also specifies the type of treatment options which are similar to what are used in drinking water treatment (i.e., primary, secondary, and solids treatment). The DST provides guidance for developing order-of-magnitude estimates of the amount of liquid and

solid (e.g., sludge, filter media) waste that may require disposal in the event of chemical or biological contamination at a wastewater treatment facility. This is based on operating parameters such as throughput and information on unit operations (e.g., rotating biological contactors, anaerobic digesters). The end result is information on the quantity and inventory of waste to be managed. The final step is guidance on handling, transport, and disposal options.

3.4 Agricultural biomass disposal

The Agricultural Biomass DST has been developed in collaboration with the U.S. Department of Agriculture (USDA). It is intended to provide guidance to personnel who are responsible for disposing of animal carcasses or plant materials in the aftermath of an event. The USDA has developed several training modules that can be accessed within the tool by clicking "Disposal Options" from the left navigation menu. Access to several other key resources for additional guidance is provided using hyperlinks to the National Center for Animal Health Emergency Management and the National Animal Health Emergency Management System Guidelines. The USDA is developing a best practices handbook on carcass disposal which the DST will link to once it is available. Figure 4 provides screenshots of the home page and an example screen to evaluate disposal options for carcasses resulting from avian flu, and an example screen for accessing information on lessons learned from previous incidents.

3.5 Natural disaster debris disposal

The Natural Disaster Debris Disposal DST is intended to provide guidance to personnel who are responsible for disposing of debris in the aftermath of a natural disaster. It provides access planning and guidance documents for the management of such debris. The tool provides access to a large number of natural disaster case studies, preparedness guidance documents, and pplicable rules and regulations. The natural disaster debris DST addresses the situation where a contaminated facility is demolished rather than restored. It also contains a database of disposal facilities and recyclers. Development of this DST began in 2006 and is in the early stages of the development process and has limited content and functionality. An initial release was provided to stakeholders in February 2007 to obtain their feedback. Information available includes:

- Case studies organized by disaster type (e.g. hurricanes, tornados, earthquakes, floods);
- Considerations for handling mass debris including hazardous, non-hazardous, and special wastes;
- Disaster debris reduction/recycle/disposal methods and equipment;
- Applicable regulations and disposal guidance; and
- Identification of potential facilities and contact information for providing safe disposal of disaster debris and opportunities for materials recovery for recycling programs.

Figure 5 shows a screenshot of the home page and information gateway that provides emergency responders quick access to information relevant to their needs.

4. NEXT STEPS

Stakeholder feedback is used to set priorities and determine additional modules and revisions. As each version of the DSTs is completed, a workshop is held with stakeholders to obtain feedback and expert review. Typically this is done by assigning "homework" as part of each workshop to determine the ease of use in working with the DST and if it succeeds in providing needed information for the decision making process. For those having responded to previous events, it is particularly helpful to get their insight and guidance.

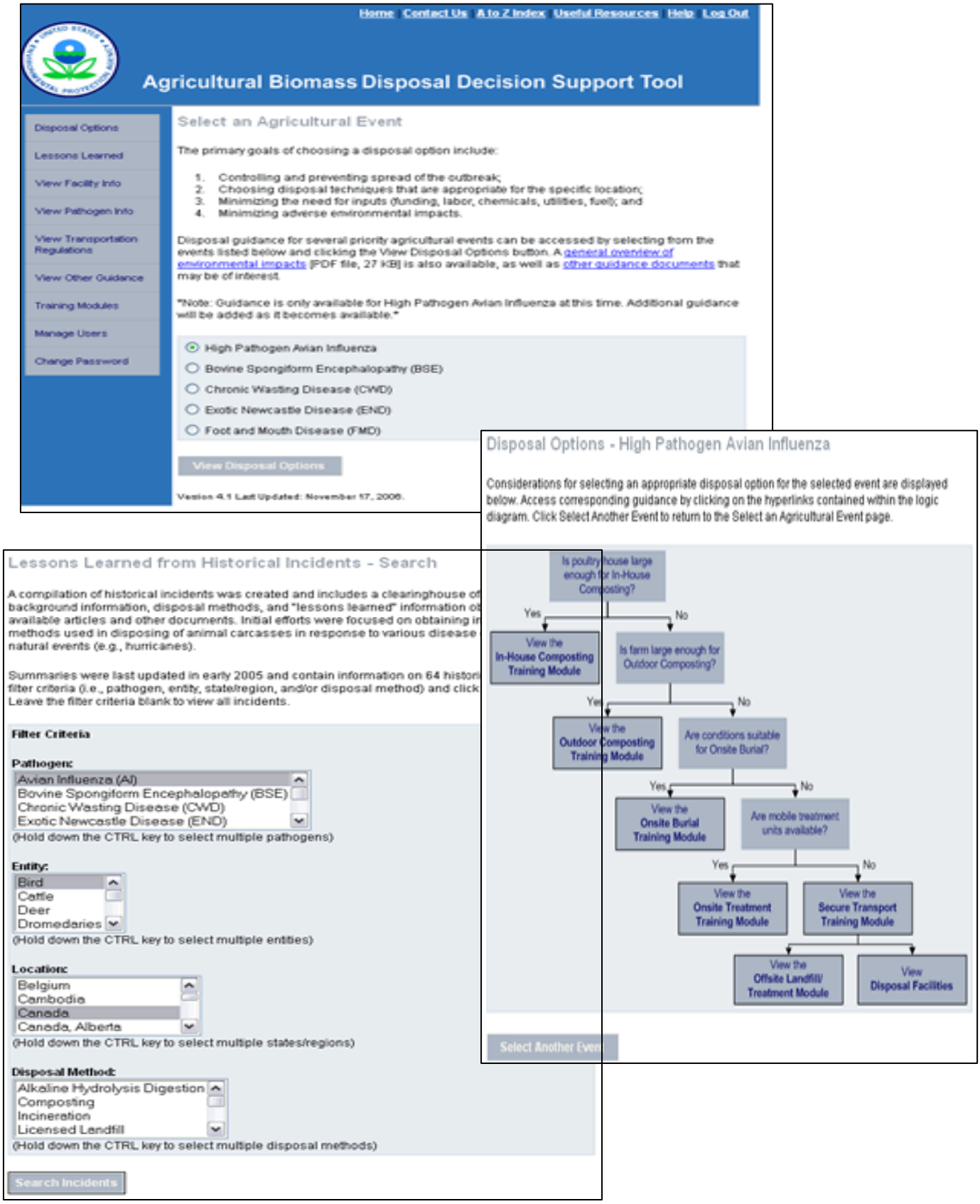

Figure 4. Screen shots from the Agricultural Biomass Disopsal DST

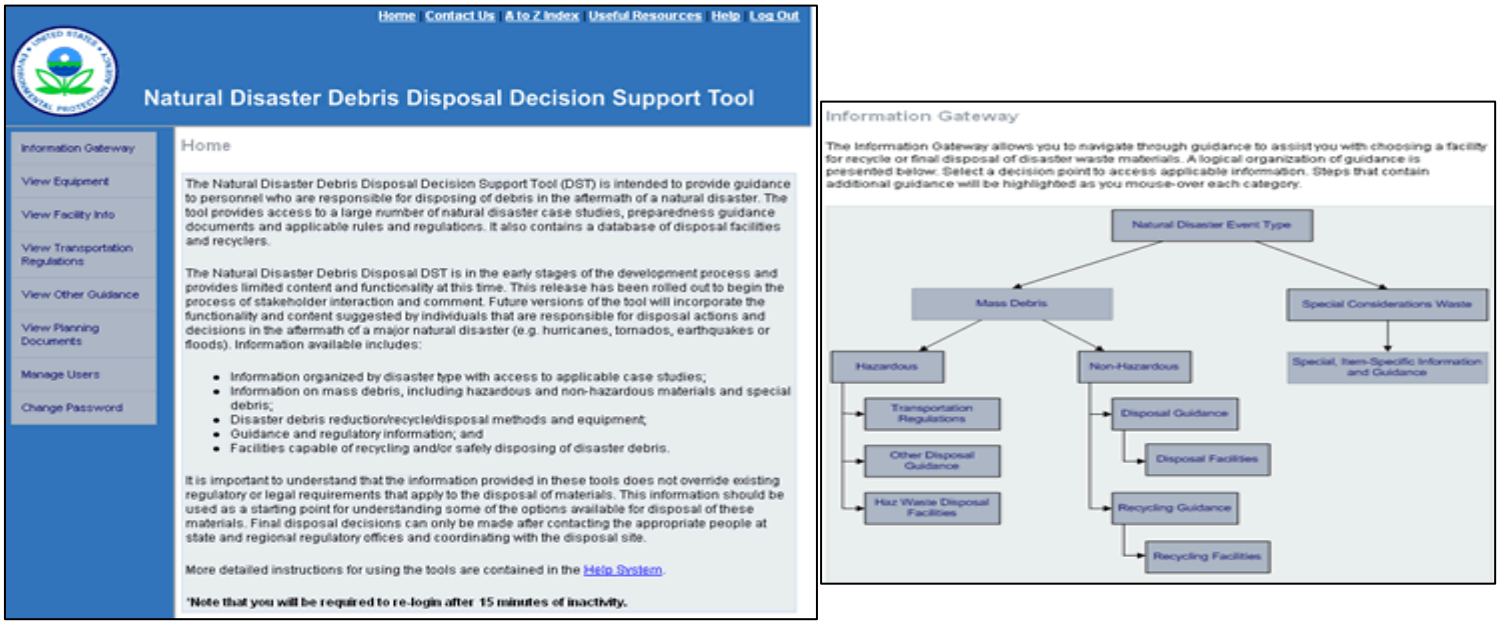

Figure 5. Screen shots from the Natural Disaster Debris Management DST

The different DSTs are in various stages of development. The decontaminated building debris DST was the first to be created and the only remaining changes are to add additional calculators for other facility types (i.e., hospitals, airports, arenas). A major focus over this next year will be to complete the DSTs for disposal of agricultural biomass and natural disaster debris. These are both being closely coordinated with stakeholders and other government agencies. For example, as additional training modules are completed by the USDA and as additional guidance is available for disposal of carcasses from contagious animal diseases, we will include updated links within the DST. For the natural disaster debris DST, we plan to link to estimation algorithms that were developed by the U.S. Army Corp of Engineers as well as incorporate lessons learned from recent events. Finally, a complex and high-priority module is being developed for disposal of waste after detonation of a radiological dispersion device.

In parallel to this research, the NHRSC is conducting research to study the thermal destruction of chemical and biological contaminants absorbed on building materials. Porous materials can be very challenging particularly when soaked in chlorine beach. Information on the types of materials, residence time, and temperatures are being determined to ensure effective destruction of potential contaminants. (Lee et al., 2005; Serre et al, 2005; Lemieux et al., 2004; Lemieux et al., 2006; Dennison et al., 2001; Dennison et al., 2005; Sieber et al., 2005) Research is also being conducted to understand the potential fate of any residual biological or chemical contaminants on debris that is landfilled. This research is to address any potential changes needed in the design and operation of a landfill to ensure worker protection as well as ensuring that disposal in a landfill will provide protection of human health and the environment. (Bartelt-Hunt et al., 2006)

5. CONCLUSIONS

EPA's Office of Research and Development has developed a suite of web-based decision support tools that will assist in the decision making process for the disposal of disaster debris. The use of the DSTs will provide decision makers information that is location-specific and contact information for disposal facility options and obtaining appropriate permits. Guidance is

also provided for handling and transportation that is specific to the different types of disasters and contaminants. Outputs from the tool such as waste profiles and characterization information can be shared with facilities and transportation companies**.** DST outputs are also helping in planning activities and understanding the costs for different disposal options. The tool is not intended to override existing regulatory or legal requirements that apply to disaster debris handling, transport, or disposal.

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