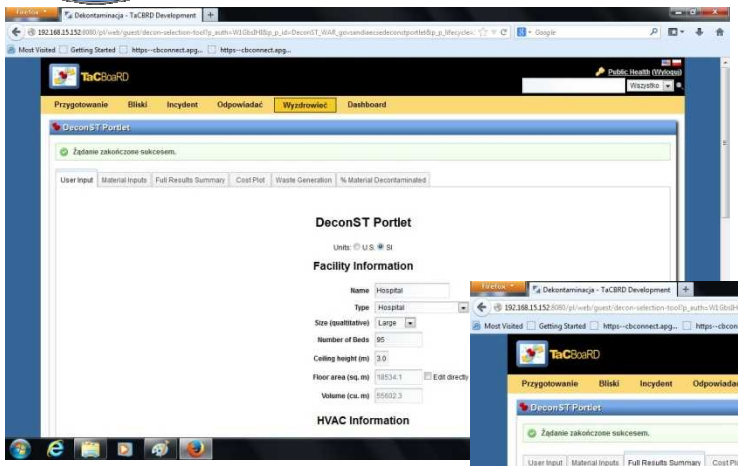
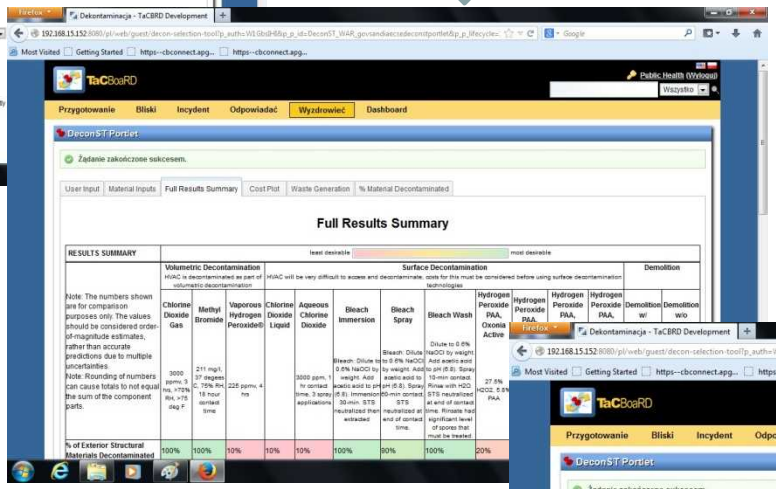
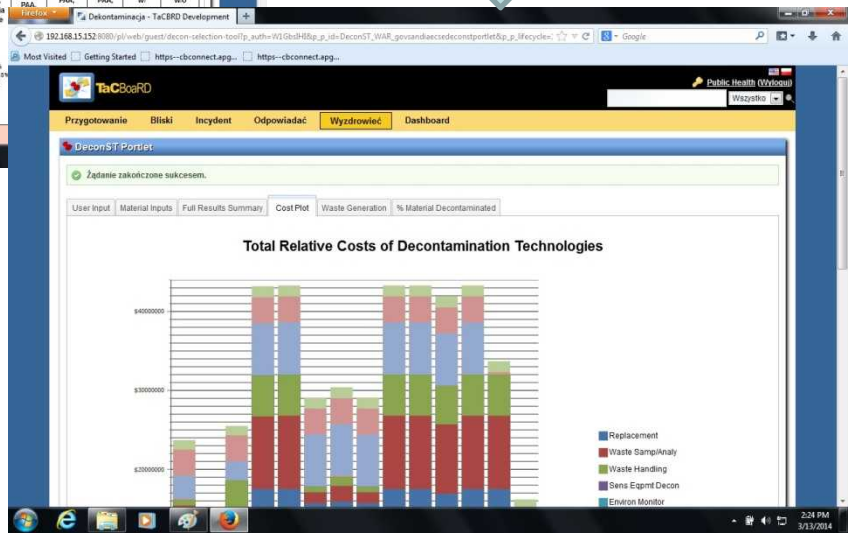
RESPONSE AND RECOVERY

Single-Building Decontamination Tool

SAND2014-2735P

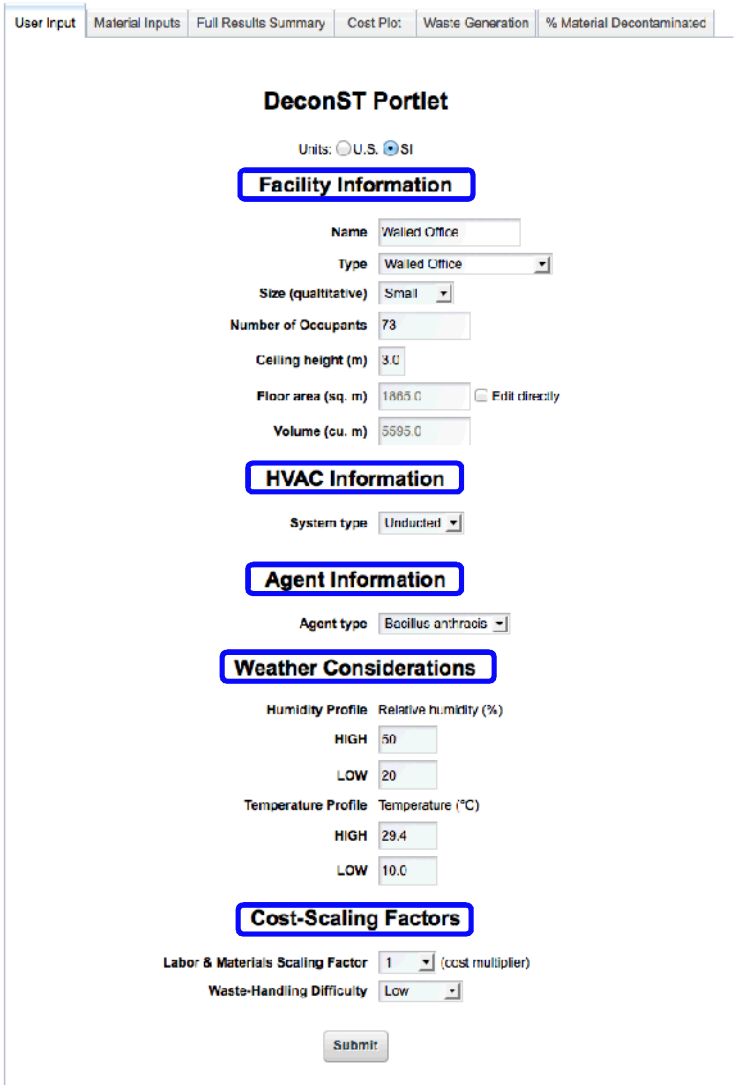






- **Single-Building Decontamination Tool**
  - **Input: Building Details**
  - **Output: Decontamination Choices with Associated Effectiveness & Costs**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



- **User Input**
  - **Facility Information**
  - **Heating, Ventilating, and Cooling System Information**
  - **Agent Information**
  - **Weather Considerations**
  - **Cost-Scaling Factors**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Material Inputs

Facility Materials (default values populated from I-WASTE Tool)	Area* Feet2	Area* Percent	Quantity* tons	Quantity* Yards3	Material Action: Keep in Place Untreated	Material Action: Remove for Alternate Decon (e.g., high-value item)	Material Action: Remove for Waste Treatment & Disposal	Material Action: Treat in Place (with facility decon technology)	Exclude: Exclude Potentially Contaminated and/or Damaged Material from Waste Stream
Exterior Structural Materials			1042.3	377.5					
Brick			93.3	67.3	○	○	○	◉	☐
Concrete			728.1	210.9	○	○	○	◉	☐
Steel			80.9	23.4	○	○	○	◉	☐
Wood			116.7	71.6	○	○	○	◉	☐
Other			23.3	14.3	○	○	○	◉	☐
Interior/Non-Structural Materials			809.0	234.3					
Total Non-Structural Building Materials									
Floors	20075		6.3	45.7					
Carpet	18032	90%	4.8	41.7	○	○	○	◉	☐
Marble and Ceramic Tiles	0	0%	0.0	0.0	○	○	○	◉	☐
Wood Flooring	0	0%	0.0	0.0	○	○	○	◉	☐
Other Floor Materials	2043	10%	1.5	4.0	○	○	○	◉	☐
Walls	44962		30.1	86.7					
Curtains and Acoustical Material	0	0%	0.0	0.0	○	○	○	◉	☐
Drywall	44962	100%	30.1	86.7	○	○	○	◉	☐
Wood	0	0%	0.0	0.0	○	○	○	◉	☐
Other Wall Materials					○	○	○	◉	☐
Ceilings	40265		7.2	77.7					
Ceiling Tiles	40265	100%	7.2	77.7	○	○	○	◉	☐
Other Ceiling Materials	0	0%			○	○	○	◉	☐
Other Non-Structural Building Materials			5.9	97.2	○	○	○	◉	☐
Art and Music Equipment			0.0	0.0	○	○	○	◉	☐
Bathroom and Kitchen Materials			0.0	0.0	○	○	○	◉	☐
Dishware			0.0	0.0	○	○	○	◉	☐
Electronic Equipment			7.3	56.1	○	○	○	◉	☐
Food			0.0	0.0	○	○	○	◉	☐
Furniture			50.8	528.6					
Porous		30%	15.2	158.6	○	○	○	◉	☐
Non-Porous		70%	35.6	370.0	○	○	○	◉	☐
Gym and Sports Equipment			0.0	0.0	○	○	○	◉	☐
Linens			0.0	0.0	○	○	○	◉	☐
Medical Supplies			0.0	0.0	○	○	○	◉	☐
Medical Waste			0.0	0.0	○	○	○	◉	☐
Paper and Office Supplies			41.2	126.4	○	○	○	◉	☐
Personal Effects			0.0	0.0	○	○	○	◉	☐
Pharmaceuticals			0.0	0.0	○	○	○	◉	☐
Other Items and Equipment			0.0	0.0	○	○	○	◉	☐

- **Building Materials**
  - Exterior
  - Interior
  - Contents
- **Treatment Options**
  - Do not decontaminate
  - Remove for alternate decontamination
  - Remove as waste
  - Decontaminate in place
  - Exclude from waste stream

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Full Results Summary

least desirable — most desirable

RESULTS SUMMARY	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)									Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray	Bleach Wash	Hydrogen Peroxide PAA, Oxonia Active	Hydrogen Peroxide PAA, Minncare	Hydrogen Peroxide PAA, Spor-klenz RTU	Hydrogen Peroxide PAA, Peridox RTU	Demolition w/ Materials Replacement	Demolition w/o Materials Replacement
	3000 ppmv, 3 hrs, >70% RH, >73 deg F	211 mg/L, 37 degees C, 75% RH, 18 hour contact time	225 ppmv, 4 hrs		3000 ppm, 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 30-min contact. STS neutralized at end of contact time.	Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	27.5% H2O2, 5.8% PAA	22% H2O2, 4.5% PAA	1% H2O2 0.08% PAA, <10% AA	4% H2O2, 0.22% PAA	Demolition labor and materials for removing, disposing, and replacing building materials	Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	$2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	$1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	55100	59800	59800	26400	51300	25700	57300	58000	53900	58000	68900	40600
Removal Time (person hours)	15300	10300	27500	31700	31700	16200	25600	15500	29200	29900	27200	29900	40800	40600
Replacement Time (person hours)	6000	5500	27600	28100	28100	10200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	1100	1200	1200	200	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	100	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	1000	1100	1100	100	200	100	900	900	800	900	1200	1200

- **Results Summary**
  - **Materials decontaminated**
  - **Total cost***
  - **Materials removal/ replacement time**
  - **Waste generated**

Note that costs are relative for the purpose of comparison; the true total cost would need to consider the cost of facility downtime, which for many facilities would likely overwhelm the cost of remediation.

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Full Results Summary

RESULTS SUMMARY	least desirable → most desirable													
	Volumetric Decontamination HVAC is decontaminated as part of volumetric decontamination			Surface Decontamination Unducted HVAC can be decontaminated as part of the facility decontamination process									Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas 3000 ppmv, 3 hrs, >70% RH, >73 deg F	Methyl Bromide 211 mg/L, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 1 hr	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide 3000 ppm, 1 hr contact time, 3 spray applications	Bleach Immersion Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach Spray Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 90-min contact. STS neutralized at end of contact time.	Bleach Wash Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O2. STS neutralized at end of contact time. Rinsate has significant level of spores that must be treated.	Hydrogen Peroxide PAA, Oxonia Active 27.5% H2O2, 5.8% PAA	Hydrogen Peroxide PAA, Minncare 22% H2O2, 4.5% PAA	Hydrogen Peroxide PAA, Spor-klenz RTU 1% H2O2 0.08% PAA, <10% AA	Hydrogen Peroxide PAA, Peridox RTU 4% H2O2, 0.22% PAA	Demolition w/ Materials Replacement Demolition labor and materials for removing, disposing, and replacing building materials	Demolition w/o Materials Replacement Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	0%	10%	10%	00%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	0%	0%	0%	0%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	0%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	0%	0%	0%	0%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	90%	90%	0%	0%	0%	%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	0%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	0%	40%	40%	0%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	0%	40%	40%	0%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	0%	10%	10%	0%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	5100	58800	59800	6400	51300	25700	57300	58000	53900	58000	68900	40600
Removal Time (person hours)	15300	10300	2750	31700	31700	6200	25600	15500	29200	29900	27200	29900	40800	40600
Replacement Time (person hours)	0000	5500	2760	28100	28100	0200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	100	1200	1200	00	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	00	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	000	1100	1100	00	200	100	900	900	800	900	1200	1200

- **Results Summary**
  - **Materials decontaminated**
  - **Total cost**
  - **Materials removal/ replacement time**
  - **Waste generated**

Key

- **Better performance**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Full Results Summary

RESULTS SUMMARY	least desirable → most desirable														
	Volumetric Decontamination HVAC is decontaminated as part of volumetric decontamination					Surface Decontamination Unducted HVAC can be decontaminated as part of the facility decontamination process							Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas 3000 ppmv, 3 hrs, >70% RH, >73 deg F	Methyl Bromide 211 mg/L, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 1 hr	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide 3000 ppm, 1 hr contact time, 3 spray applications	Bleach Immersion Bleach: Dilute to 0.6% NaOCl by weight. Acid acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach Spray Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 30-min contact. STS neutralized at end of contact time.	Bleach Wash Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O2. STS neutralized at end of contact time. Rinsate has significant level of spores that must be treated.	Hydrogen Peroxide PAA, Oxonia Active 27.5% H2O2, 5.8% PAA	Hydrogen Peroxide PAA, Minncare 22% H2O2, 4.5% PAA	Hydrogen Peroxide PAA, Spor-klenz RTU 1% H2O2 0.08% PAA, <10% AA	Hydrogen Peroxide PAA, Peridox RTU 4% H2O2, 0.22% PAA	Demolition w/ Materials Replacement Demolition labor and materials for removing, disposing, and replacing building materials	Demolition w/o Materials Replacement Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	0%	10%	10%	00%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	0%	0%	0%	0%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	0%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	0%	0%	0%	0%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	90%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	0%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	0%	40%	40%	0%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	0%	40%	40%	0%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	0%	10%	10%	0%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	$2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	$1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	5100	59800	59800	6400	51300	25700	57300	58000	53900	58000	68900	40600
Removal Time (person hours)	15300	10300	2750	31700	31700	6200	25600	15500	29200	29900	27200	29900	40800	40600
Replacement Time (person hours)	0000	5500	2760	28100	28100	0200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	100	1200	1200	00	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	00	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	000	1100	1100	00	200	100	900	900	800	900	1200	1200

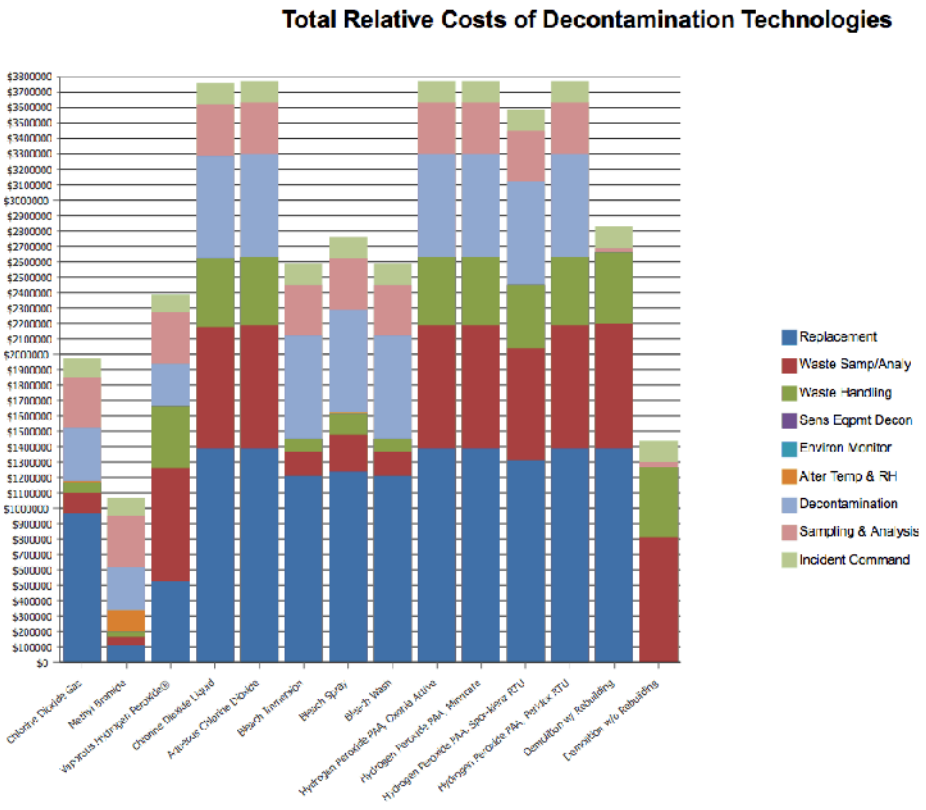
- **Results Summary**
  - **Materials decontaminated**
  - **Total cost**
  - **Materials removal/ replacement time**
  - **Waste generated**

Key

- **Better performance**
- **Worse performance**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

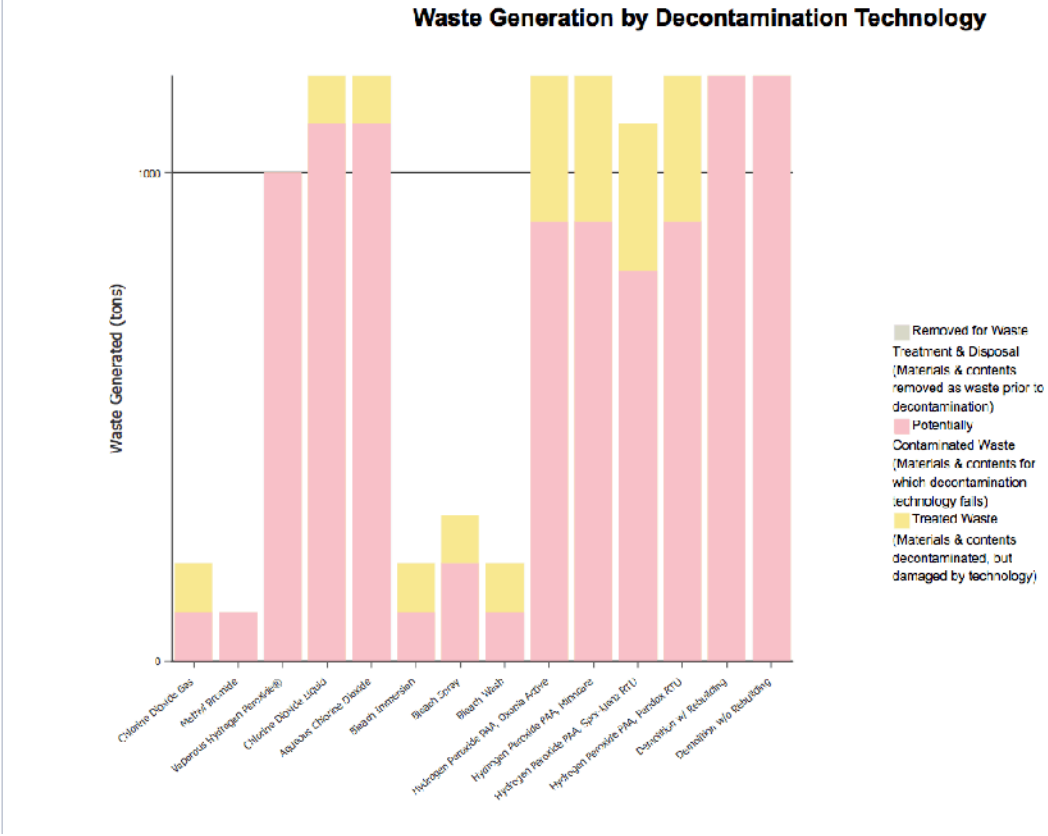
User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated



- **Total Relative Costs of Decontamination Technologies**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

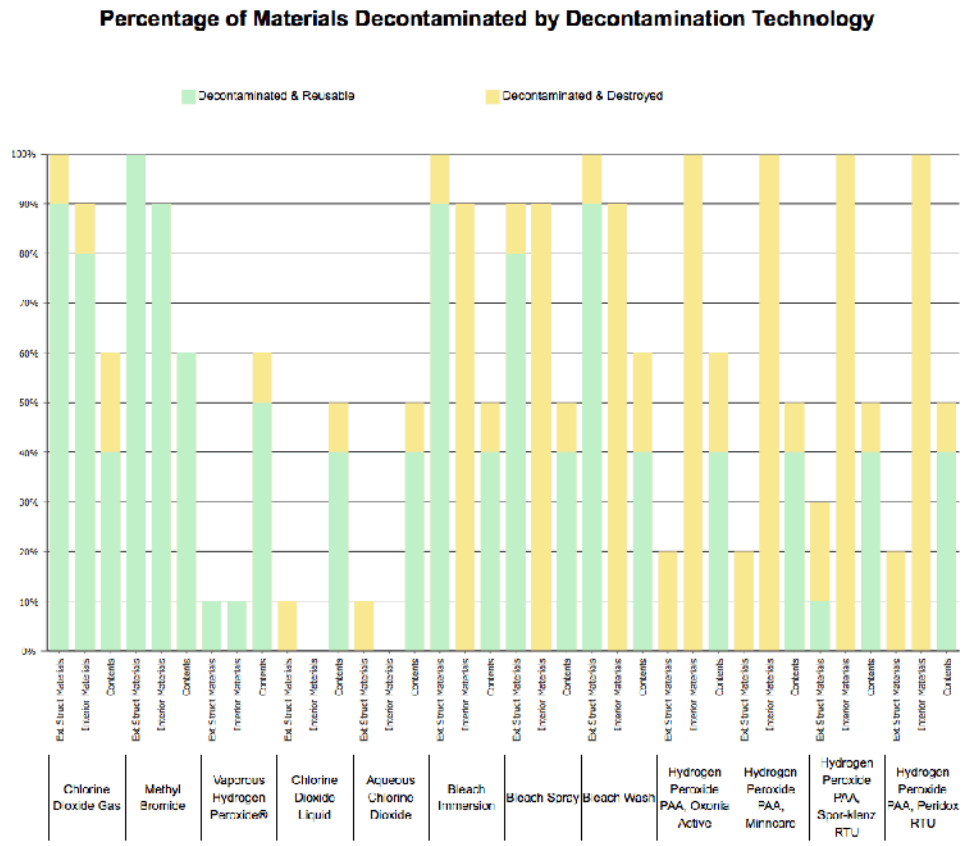
User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated



- **Waste Generated**

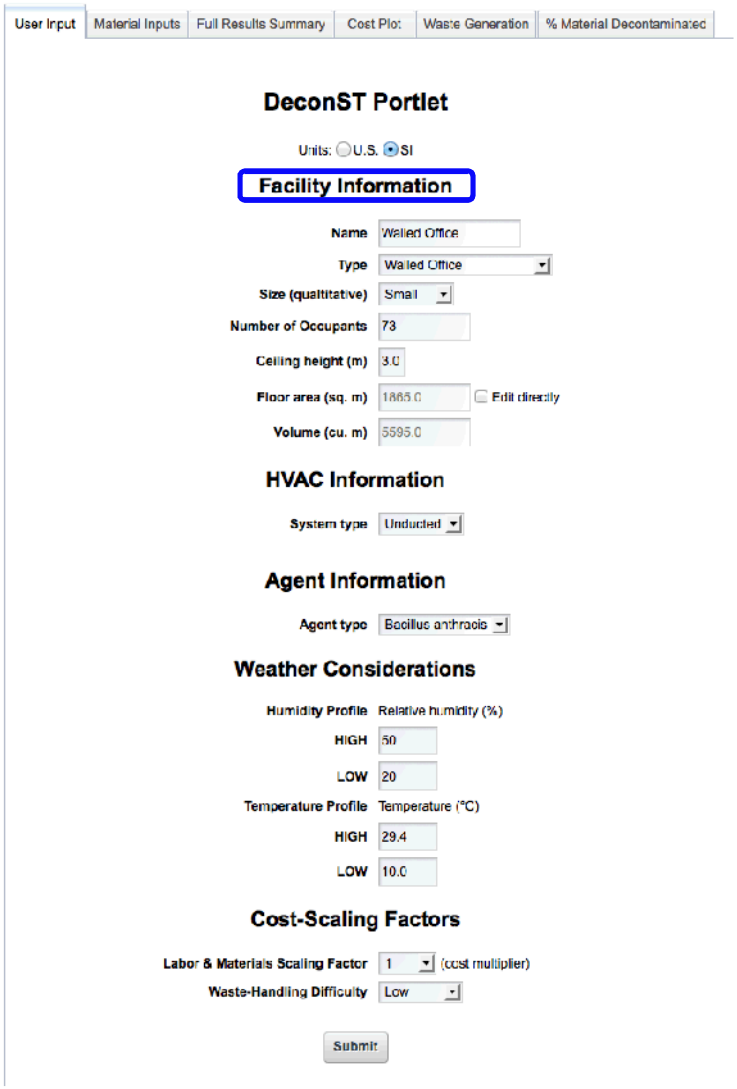
RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated



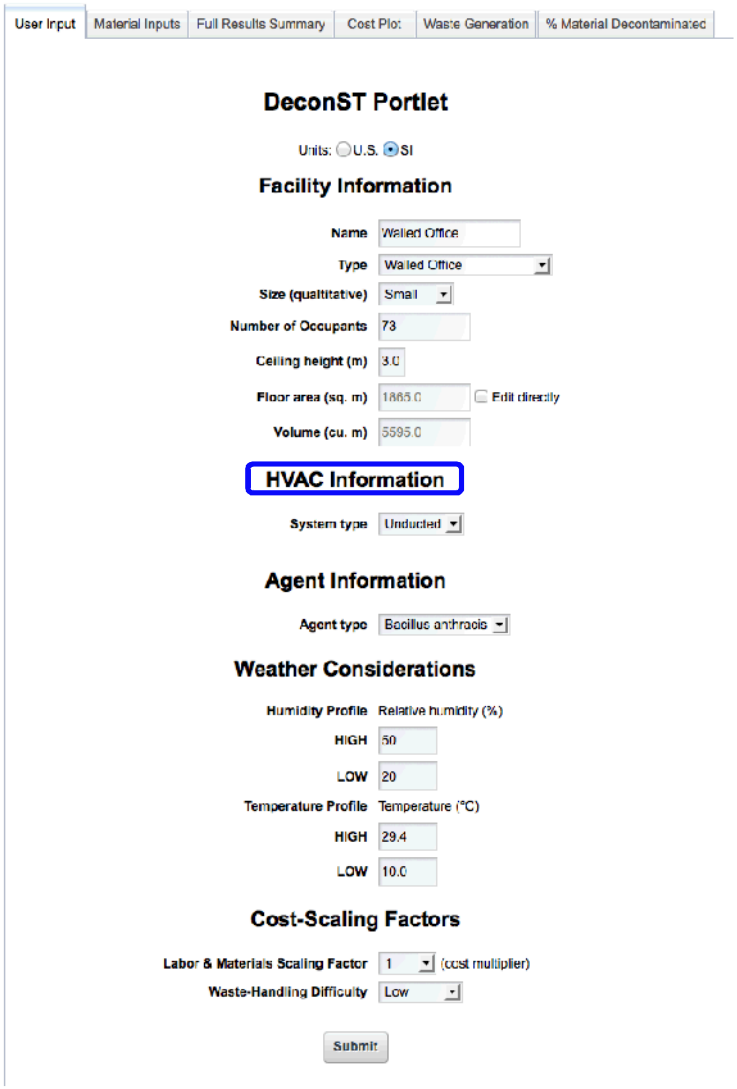
- **Materials Decontaminated**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



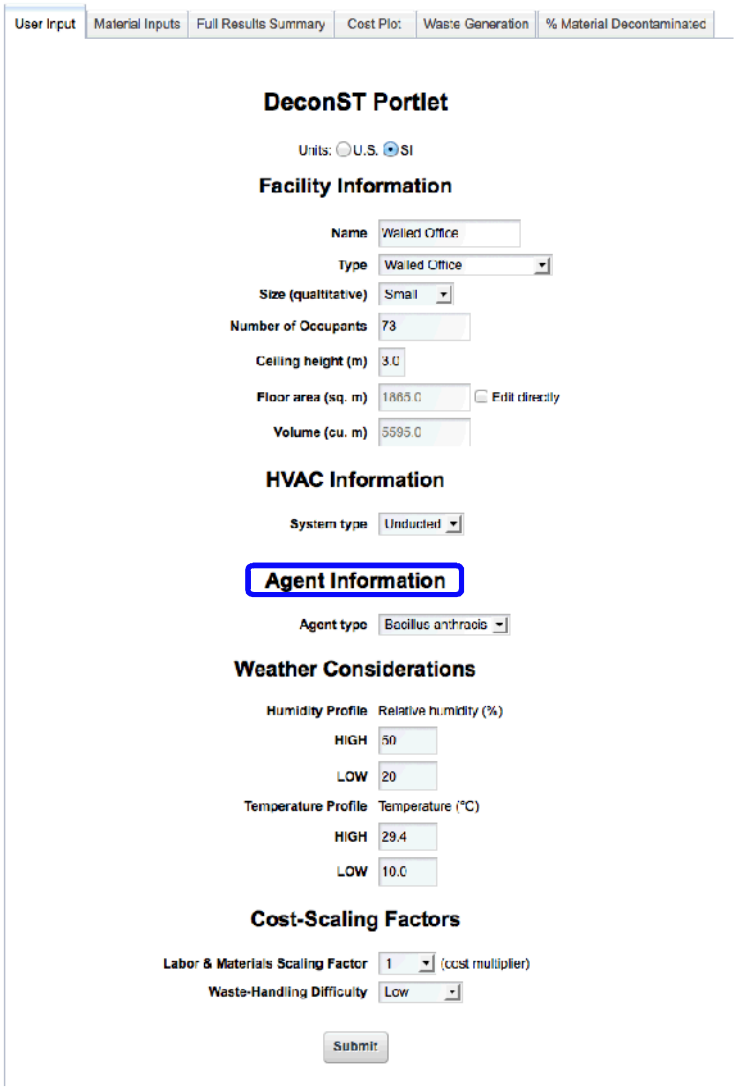
- **User Input - Detail**
  - **Facility Information**
    - **Type**
    - **Size**
    - **Facility-specific parameters**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



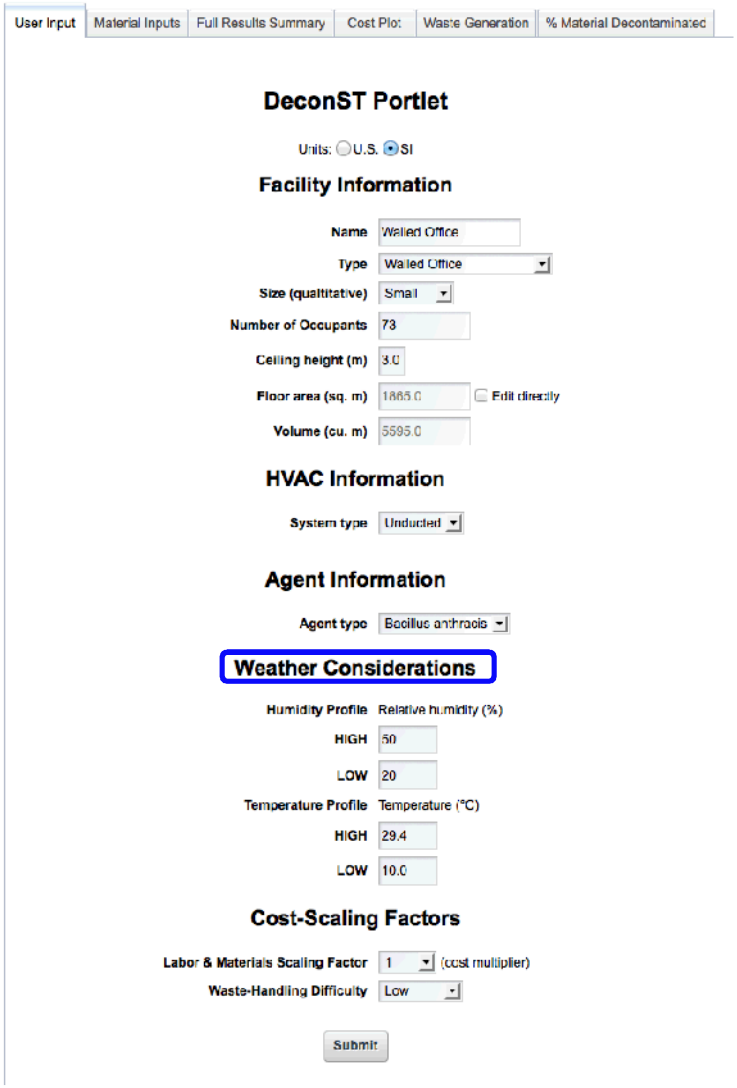
- **User Input - Detail**
  - **Heating, Ventilating, and and Cooling System Information**
    - **Ducted / unducted**
    - **Lined / unlined**
    - **Accessiblility**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



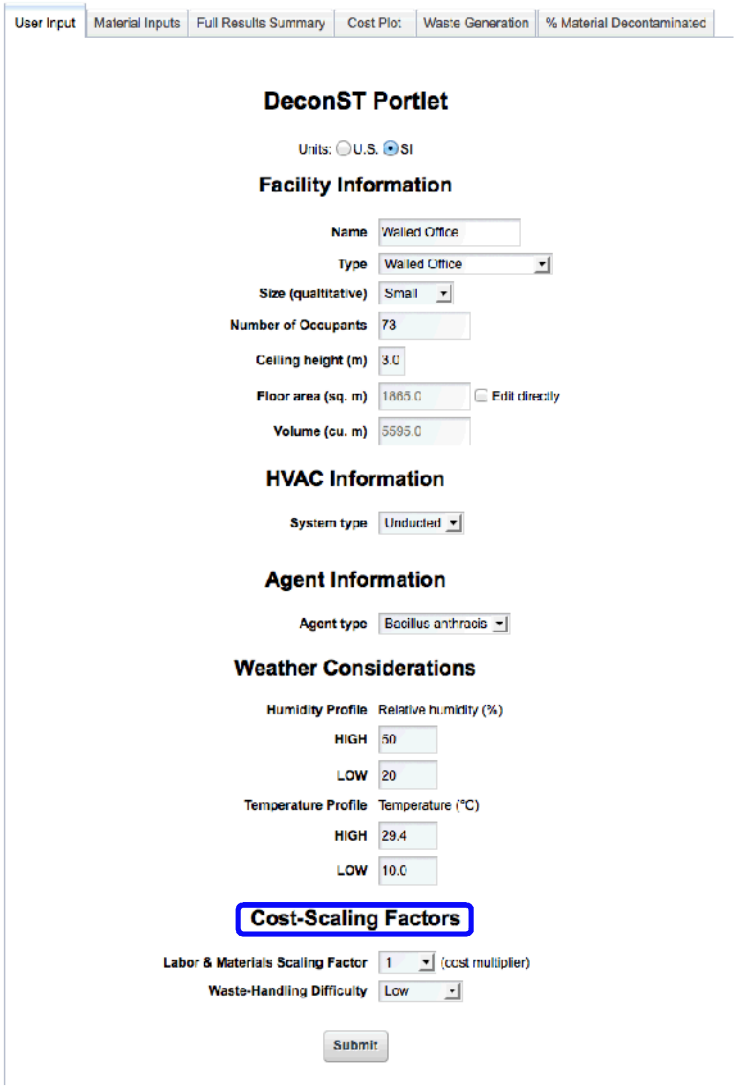
- **User Input - Detail**
  - **Agent Information**
    - **Bacillus anthracis**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



- **User Input - Detail**
  - **Weather Considerations**
    - **Humidity**
    - **Temperature**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



- **User Input - Detail**
  - **Cost-Scaling Factors**
    - **Labor & Materials**
      - **relative to United States national average**
    - **Waste-Handling Difficulty Transportation & Disposal Costs**
      - **Low = $250 / ton**
      - **Medium = $2,500 / ton**
      - **High = $25,000 / ton**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Material Inputs

Facility Materials (default values populated from I-WASTE Tool)	Area* Feet2	Area* Percent	Quantity* tons	Quantity* Yards3	Material Action: Keep in Place Untreated	Material Action: Remove for Alternate Decon (e.g., high-value item)	Material Action: Remove for Waste Treatment & Disposal	Material Action: Treat in Place (with facility decon technology)	Exclude: Exclude Potentially Contaminated and/or Damaged Material from Waste Stream
Exterior Structural Materials			1042.3	377.5					
Brick			93.3	67.3	○	○	○	◉	☐
Concrete			728.1	210.9	○	○	○	◉	☐
Steel			80.9	23.4	○	○	○	◉	☐
Wood			116.7	71.6	○	○	○	◉	☐
Other			23.3	14.3	○	○	○	◉	☐
Interior/Non-Structural Materials			809.0	234.3					
Total Non-Structural Building Materials									
Floors	20075		6.3	45.7					
Carpet	18032	90%	4.8	41.7	○	○	○	◉	☐
Marble and Ceramic Tiles	0	0%	0.0	0.0	○	○	○	◉	☐
Wood Flooring	0	0%	0.0	0.0	○	○	○	◉	☐
Other Floor Materials	2043	10%	1.5	4.0	○	○	○	◉	☐
Walls	44962		30.1	86.7					
Curtains and Acoustical Material	0	0%	0.0	0.0	○	○	○	◉	☐
Drywall	44962	100%	30.1	86.7	○	○	○	◉	☐
Wood	0	0%	0.0	0.0	○	○	○	◉	☐
Other Wall Materials					○	○	○	◉	☐
Ceilings	40265		7.2	77.7					
Ceiling Tiles	40265	100%	7.2	77.7	○	○	○	◉	☐
Other Ceiling Materials	0	0%			○	○	○	◉	☐
Other Non-Structural Building Materials			5.9	97.2	○	○	○	◉	☐
Art and Music Equipment			0.0	0.0	○	○	○	◉	☐
Bathroom and Kitchen Materials			0.0	0.0	○	○	○	◉	☐
Dishware			0.0	0.0	○	○	○	◉	☐
Electronic Equipment			7.3	56.1	○	○	○	◉	☐
Food			0.0	0.0	○	○	○	◉	☐
Furniture			50.8	528.6					
Porous		30%	15.2	158.6	○	○	○	◉	☐
Non-Porous		70%	35.6	370.0	○	○	○	◉	☐
Gym and Sports Equipment			0.0	0.0	○	○	○	◉	☐
Linens			0.0	0.0	○	○	○	◉	☐
Medical Supplies			0.0	0.0	○	○	○	◉	☐
Medical Waste			0.0	0.0	○	○	○	◉	☐
Paper and Office Supplies			41.2	126.4	○	○	○	◉	☐
Personal Effects			0.0	0.0	○	○	○	◉	☐
Pharmaceuticals			0.0	0.0	○	○	○	◉	☐
Other Items and Equipment			0.0	0.0	○	○	○	◉	☐

- **Materials Inputs Detail**
  - **User-adjustable quantities**
- **Treatment Options**
  - **Do not decontaminate**
  - **Remove for alternate decontamination**
  - **Remove as waste**
  - **Decontaminate in place**
  - **Exclude from waste stream**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Full Results Summary

least desirable — most desirable

RESULTS SUMMARY	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)									Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas 3000 ppmv, 3 hrs, >70% RH, >73 deg F	Methyl Bromide 211 mg/L, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 1 hrs	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide 3000 ppm, 1 hr contact time, 3 spray applications	Bleach Immersion Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach Spray Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 90-min contact. STS neutralized at end of contact time.	Bleach Wash Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	Hydrogen Peroxide PAA, Oxonia Active 27.5% H2O2, 5.5% PAA	Hydrogen Peroxide PAA, Minncare 22% H2O2, 4.5% PAA	Hydrogen Peroxide PAA, Spor-klenz RTU 1% H2O2 0.08% PAA, <10% AA	Hydrogen Peroxide PAA, Peridox RTU 4% H2O2, 0.22% PAA	Demolition w/ Materials Replacement Demolition labor and materials for removing, disposing, and replacing building materials	Demolition w/o Materials Replacement Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	$2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	$1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	55100	59800	59800	26400	51300	25700	57300	58000	53900	58000	68900	40600
Removal Time (person hours)	15300	10300	27500	31700	31700	16200	25600	15500	29200	29900	27200	29900	40800	40600
Replacement Time (person hours)	6000	5500	27600	28100	28100	10200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	1100	1200	1200	200	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	100	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	1000	1100	1100	100	200	100	900	900	800	900	1200	1200

- **Results Summary**
- **Decontamination strategies & technologies**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Full Results Summary

least desirable — most desirable

RESULTS SUMMARY	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)									Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray	Bleach Wash	Hydrogen Peroxide PAA, Oxonia Active	Hydrogen Peroxide PAA, Minncare	Hydrogen Peroxide PAA, Spor-klenz RTU	Hydrogen Peroxide PAA, Peridox RTU	Demolition w/ Materials Replacement	Demolition w/o Materials Replacement
	3000 ppmv, 3 hrs, >70% RH, >73 deg F	241 mg/L, 37 degees C, 75% RH, 18 hour contact time	225 ppmv, 4 hrs		3000 ppm, 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 30-min contact. STS neutralized at end of contact time.	Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	27.5% H2O2, 5.8% PAA	22% H2O2, 4.5% PAA	1% H2O2 0.08% PAA, <10% AA	4% H2O2, 0.22% PAA	Demolition labor and materials for removing, disposing, and replacing building materials	Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	50%	50%	50%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	50%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	$2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	$1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	55100	59800	59800	26400	51300	25700	57300	58000	53900	58000	68900	40600
Removal Time (person hours)	15300	10300	27500	31700	31700	16200	25600	15500	29200	29900	27200	29900	40800	40600
Replacement Time (person hours)	6000	5500	27600	28100	28100	10200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	1100	1200	1200	200	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	100	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	1000	1100	1100	100	200	100	900	900	800	900	1200	1200

- **Results Summary**
  - Decontamination strategies & technologies
  - **Percentage of Materials Decontaminated**
    - **Exterior**
    - **Interior**
    - **Contents**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Full Results Summary

least desirable — most desirable

RESULTS SUMMARY	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)									Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas 3000 ppmv, 3 hrs, >70% RH, >73 deg F	Methyl Bromide 211 mg/L, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 1 hr	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide 3000 ppm, 1 hr contact time, 3 spray applications	Bleach Immersion Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach Spray Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 30-min contact. STS neutralized at end of contact time.	Bleach Wash Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	Hydrogen Peroxide PAA, Oxonia Active 27.5% H2O2, 5.8% PAA	Hydrogen Peroxide PAA, Minncare 22% H2O2, 4.5% PAA	Hydrogen Peroxide PAA, Spor-klenz RTU 1% H2O2 0.08% PAA, <10% AA	Hydrogen Peroxide PAA, Peridox RTU 4% H2O2, 0.22% PAA	Demolition w/ Materials Replacement Demolition labor and materials for removing, disposing, and replacing building materials	Demolition w/o Materials Replacement Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	$2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	$1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	55100	59800	59800	26400	51300	25700	57300	58000	53900	58000	58900	40600
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Replacement Time (person hours)	6000	5500	27600	28100	28100	10200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	1100	1200	1200	200	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	100	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	1000	1100	1100	100	200	100	900	900	800	900	1200	1200

- **Results Summary**
  - Decontamination strategies & technologies
  - Percentage of Materials Decontaminated
  - **Total Cost***
    - **Decontamination Process**
    - **Waste Management**

Note that costs are relative for the purpose of comparison; the true total cost would need to consider the cost of facility downtime, which for many facilities would likely overwhelm the cost of remediation.

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Single-Building Decontamination Tool

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Full Results Summary

least desirable — most desirable

RESULTS SUMMARY	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)									Demolition	
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	3000 ppmv, 3 hrs, >70% RH, >73 deg F	241 mg/L, 37 degees C, 75% RH, 18 hour contact time	225 ppmv, 4 hrs		3000 ppm, 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 30-min contact. STS neutralized at end of contact time.	Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	27.5% H2O2, 5.8% PAA	22% H2O2, 4.5% PAA	1% H2O2 0.08% PAA, <10% AA	4% H2O2, 0.22% PAA	Demolition labor and materials for removing, disposing, and replacing building materials	Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	$2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	$1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	55100	59800	59800	26400	51300	25700	57300	58000	53900	58000	68900	40600
Removal Time (person hours)	15300	10300	27500	31700	31700	16200	25600	15500	29200	29900	27200	29900	40800	40600
Replacement Time (person hours)	6000	5500	27600	28100	28100	10200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	1100	1200	1200	200	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	100	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	1000	1100	1100	100	200	100	900	900	800	900	1200	1200

- **Results Summary**
  - Decontamination strategies & technologies
  - Percentage of Materials Decontaminated
  - Total Cost
  - **Materials Removal/ Replacement Time**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

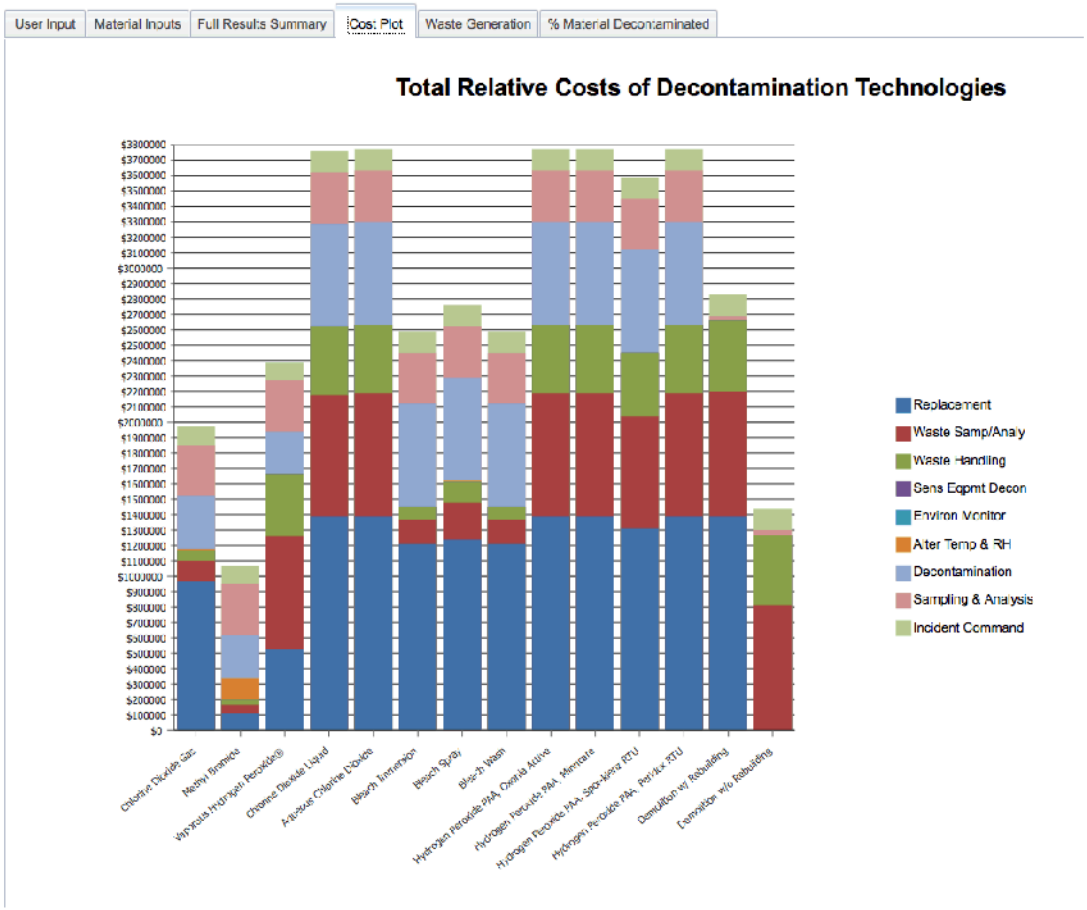
User Input | Material Inputs | Full Results Summary | Cost Plot | Waste Generation | % Material Decontaminated

Full Results Summary

RESULTS SUMMARY	least desirable → most desirable													
	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)			Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)									Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray	Bleach Wash	Hydrogen Peroxide PAA, Oxonia Active	Hydrogen Peroxide PAA, Minncare	Hydrogen Peroxide PAA, Spor-klenz RTU	Hydrogen Peroxide PAA, Peridox RTU	Demolition w/ Materials Replacement	Demolition w/o Materials Replacement
	3000 ppmv, 3 hrs, >70% RH, >73 deg F	211 mg/L, 37 degees C, 75% RH, 18 hour contact time	225 ppmv, 4 hrs		3000 ppm, 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 20-min. STS neutralized then extracted	Bleach: Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 30-min contact. STS neutralized at end of contact time.	Dilute to 0.5% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinse had significant level of spores that must be treated.	27.5% H2O2, 5.8% PAA	22% H2O2, 4.5% PAA	1% H2O2 0.08% PAA, <10% AA	4% H2O2, 0.22% PAA	Demolition labor and materials for removing, disposing, and replacing building materials	Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$2.2	$1.2	$3.0	$4.5	$4.5	$2.8	$3.0	$2.8	$4.5	$4.5	$4.2	$4.5	$3.6	$2.3
Decon Process Cost, $M	$0.8	$0.9	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$1.4	$0.3	$2.3	$3.3	$3.4	$1.7	$1.9	$1.7	$3.3	$3.3	$3.0	$3.3	$3.6	$2.1
Material Removal/Replacement Time	21300	15800	55100	59800	59800	26400	51300	25700	57300	58000	53900	58000	68900	40600
Removal Time (person hours)	15300	10300	27500	31700	31700	16200	25600	15500	29200	29900	27200	29900	40800	40600
Replacement Time (person hours)	6000	5500	27600	28100	28100	10200	25700	10200	28100	28100	26700	28100	28100	0
Total Waste Generated (tons)	200	100	1100	1200	1200	200	300	200	1200	1200	1100	1200	1200	1200
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	100	0	0	100	100	100	100	100	300	300	300	300	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	100	100	1000	1100	1100	100	200	100	900	900	800	900	1200	1200

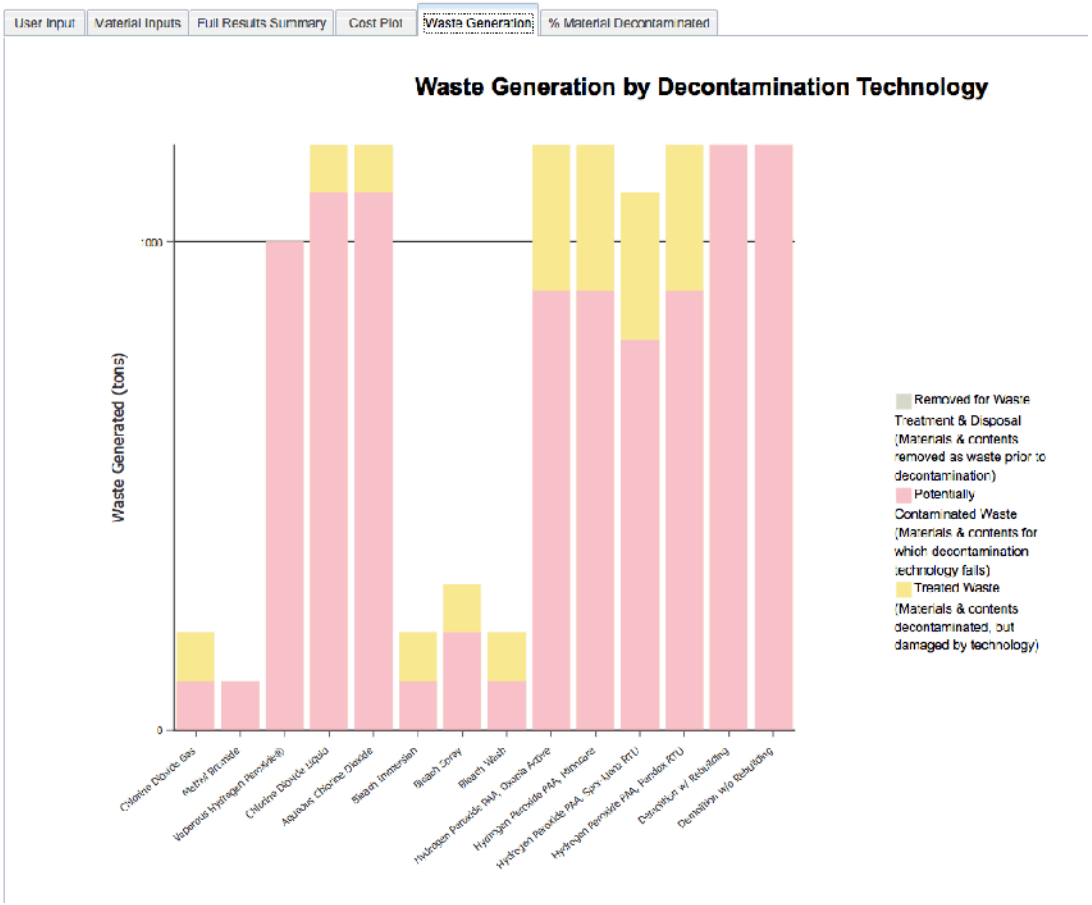
- **Results Summary**
  - Decontamination strategies & technologies
  - Percentage of Materials Decontaminated
  - Total Cost
  - Materials Removal/ Replacement Time
  - **Total Waste Generated**
    - **Removed prior to building decontamination**
    - **Potentially contaminated waste**
    - **Treated waste**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



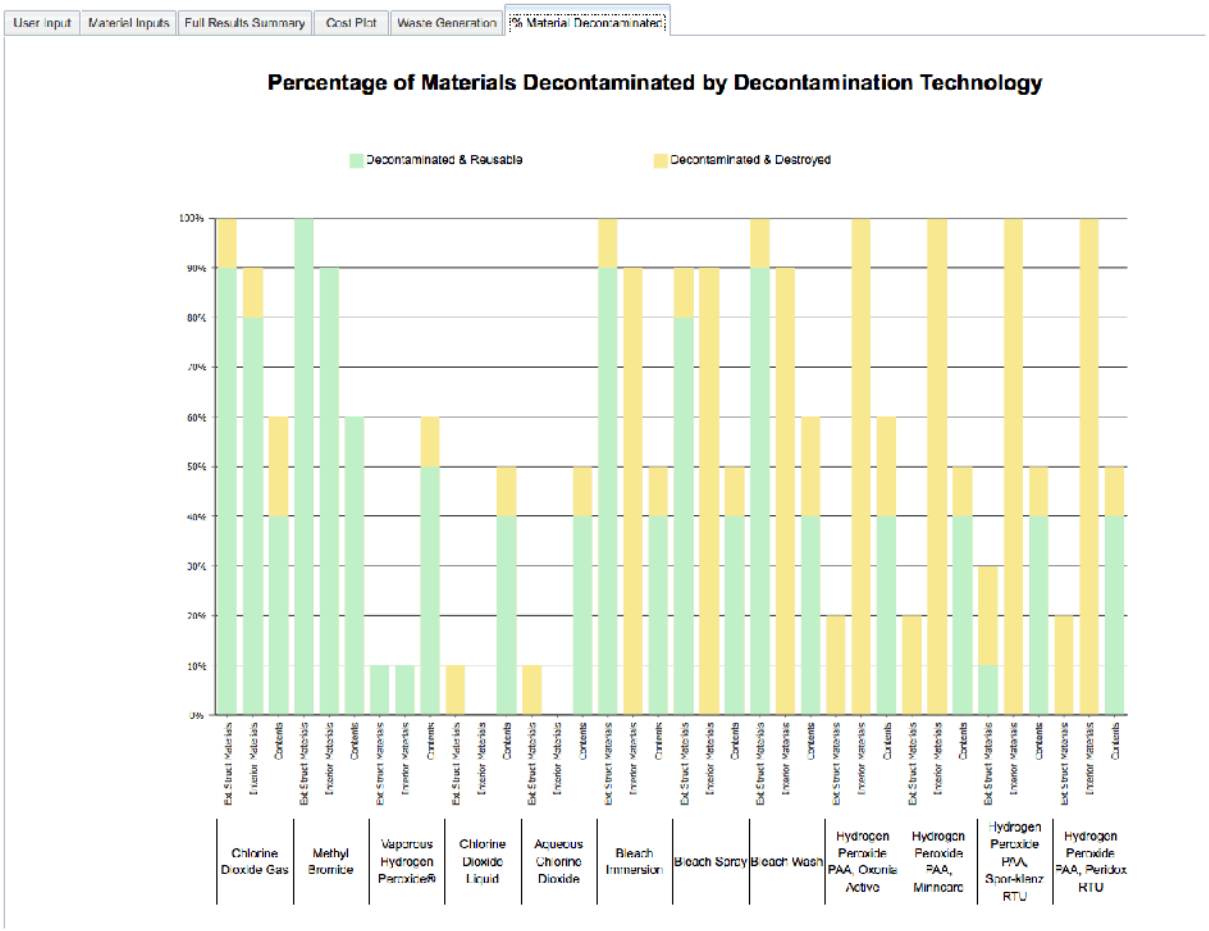
- **Total Relative Costs of Decontamination Technologies**
  - Incident command
  - Sampling & analysis
  - Decontamination
  - Heaters/coolers and humidifiers/dehumidifiers
  - Environmental monitoring
  - Sensitive equipment decontamination
  - Waste handling
  - Waste sampling & analysis
  - Materials replacement

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



- **Waste Generated**
  - **Removed prior to building decontamination**
  - **Potentially contaminated waste**
  - **Treated waste**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool



- **Materials Decontaminated**
  - **Reusable**
  - **Destroyed**

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

- **Exercises – Important Infrastructure Facilities**
  - Results will be used for afternoon Practicum
  - Cost Scaling = 0.1, Waste-Handling Difficulty = medium
  - Weather: Humidity = 45%-90%, Temperature = 7°C-18°C

- **Important Infrastructure Facility #1**
  - **Hospital**
  - **Type** = Hospital
  - **Large** = 18,500 m^2
  - **Number of Beds** = 95
  - **HVAC info** = Ducted, lined, less-accessible
  - **Print results** – needed for practicum

- **Important Infrastructure Facility #2**
  - **Government Office**
  - **Type** = Walled Office Building
  - **Large** = 24,200 m^2
  - **Number of Occupants** = 947
  - **HVAC info** = Unducted
  - **Print results** – needed for practicum

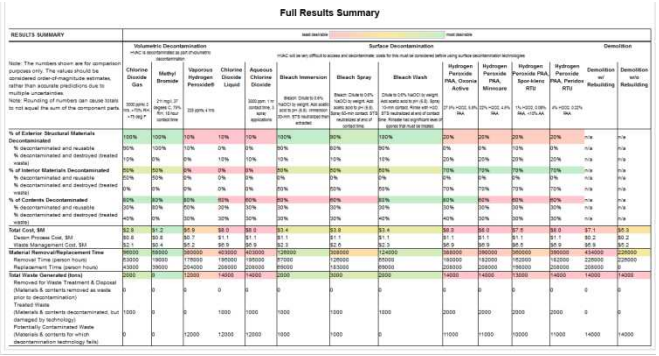
- **Important Infrastructure Facility #3**
  - **US Consulate**
  - **Type** = Walled Office Building
  - **Medium** = 7,400 m^2
  - **Number of Occupants** = 291
  - **HVAC info** = Unducted
  - **Print results** – needed for practicum

- **Important Infrastructure Facility #4**
  - **Adam Mickiewicz High School**
  - **Type** = High School
  - **Floor Area** = 12,600 m^2
  - **Number of Students**= 677
  - **HVAC info** = Unducted
  - **Print results** – needed for practicum

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

- **Exercises – Important Infrastructure Facilities**
  - Results will be used for afternoon Practicum
  - Cost Scaling = 0.1, Waste-Handling Difficulty = medium
  - Weather: Humidity = 45%-90%, Temperature = 7°C-18°C

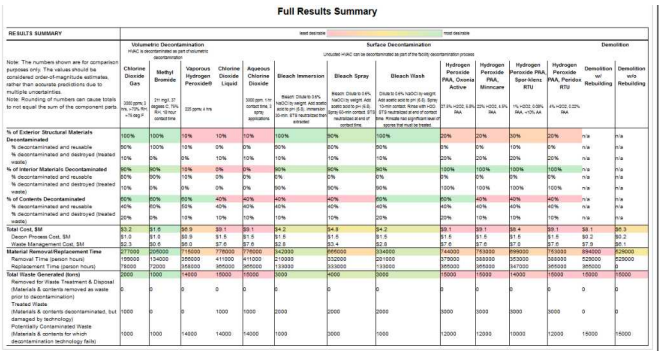
- **Important Infrastructure Facility #1**


Full Results Summary

RESULTS SUMMARY

Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Volumetric Decontamination (HVAC is decontaminable as part of volumetric decontamination)					Surface Decontamination (HVAC will be very difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies)								Demolition	
	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray	Bleach Wash	Hydrogen Peroxide PNA, Oxonia Active	Hydrogen Peroxide PNA, Minncare	Hydrogen Peroxide PNA, Spor-klenz RTU	Hydrogen Peroxide PNA, Peridox RTU	Demolition w/ Rebuilding	Demolition w/o Rebuilding
	3000 ppmv 3 hrs, >70% RH, >75 deg F	21 mg/L 37 degrees C, 75% RH, 10 hour contact time	225 ppmv 4 hrs		3000 ppm 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Immerse 10-min. RTB neutralized then extracted	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	27.9% >2X2, 6.8% >4X4, >70% RH	2% >2X2, 4.9% >4X4	1% >2X2, 0.68% >4X4, >70% RH	4% >2X2, 0.22% >4X4		
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	20%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	80%	80%	0%	0%	0%	80%	80%	80%	70%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	80%	80%	0%	0%	0%	80%	80%	80%	70%	70%	70%	70%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	n/a	n/a
% decontaminated and reusable	20%	60%	60%	20%	20%	20%	20%	20%	20%	20%	20%	20%	n/a	n/a
% decontaminated and destroyed (treated waste)	40%	0%	0%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
Total Cost, $M	$2.8	$1.2	$6.9	$8.0	$8.0	$3.4	$3.8	$3.4	$8.2	$6.0	$7.8	$6.0	$7.1	$6.3
Decon Process Cost, $M	$0.8	$0.2	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$2.1	$0.4	$6.2	$6.9	$6.9	$2.3	$2.6	$2.3	$6.9	$4.9	$6.8	$4.9	$6.8	$6.2
Material Removal/Replacement Time	96000	96000	360000	457000	457000	228000	228000	228000	1240000	1240000	1240000	1240000	2280000	2280000
Removal Time (person hours)	83000	19000	178000	195000	195000	87000	126000	85000	190000	182000	182000	182000	226000	226000
Replacement Time (person hours)	43000	77000	354000	208000	208000	85000	153000	85000	338000	208000	208000	208000	0	0
Total Waste Generated (tons)	2000	1000	12000	14000	14000	2000	3000	2000	14000	14000	13000	14000	14000	14000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	1000	0	0	1000	1000	1000	1000	1000	2000	2000	2000	2000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	0	0	12000	12000	12000	1000	1000	0	11000	11000	10000	11000	14000	14000

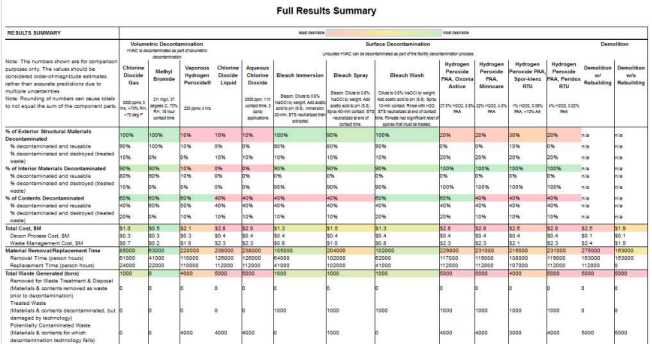
- **Important Infrastructure Facility #2**


Full Results Summary

RESULTS SUMMARY

Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Volumetric Decontamination (HVAC is decontaminable as part of volumetric decontamination)					Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)								Demolition	
	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray	Bleach Wash	Hydrogen Peroxide PNA, Oxonia Active	Hydrogen Peroxide PNA, Minncare	Hydrogen Peroxide PNA, Spor-klenz RTU	Hydrogen Peroxide PNA, Peridox RTU	Demolition w/ Rebuilding	Demolition w/o Rebuilding
	3000 ppmv 3 hrs, >70% RH, >75 deg F	21 mg/L 37 degrees C, 75% RH, 10 hour contact time	225 ppmv 4 hrs		3000 ppm 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Immerse 10-min. RTB neutralized then extracted	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	27.9% >2X2, 6.8% >4X4, >70% RH	2% >2X2, 4.9% >4X4	1% >2X2, 0.68% >4X4, >70% RH	4% >2X2, 0.22% >4X4		
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	20%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	70%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	90%	90%	10%	0%	0%	90%	90%	90%	70%	70%	70%	70%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	40%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	60%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	20%	10%	20%	n/a	n/a
Total Cost, $M	$3.2	$1.8	$6.9	$8.1	$8.1	$4.2	$4.8	$4.2	$8.1	$8.1	$8.4	$8.1	$8.1	$6.3
Decon Process Cost, $M	$1.0	$1.0	$0.9	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$0.2	$0.2
Waste Management Cost, $M	$2.1	$0.8	$6.0	$6.5	$6.5	$2.6	$3.1	$2.6	$6.5	$6.5	$6.8	$6.5	$7.9	$6.1
Material Removal/Replacement Time	277000	205000	715000	778000	778000	342000	695000	534000	744000	743000	899000	763000	894000	626000
Removal Time (person hours)	155000	134000	356000	411000	411000	213000	332000	201000	375000	368000	353000	368000	528000	526000
Replacement Time (person hours)	78000	72000	358000	365000	365000	133000	333000	133000	365000	365000	547000	365000	365000	0
Total Waste Generated (tons)	2000	1000	14000	15000	15000	3000	4000	3000	15000	15000	14000	15000	15000	15000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	1000	0	0	1000	1000	1000	1000	1000	2000	2000	2000	2000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	1000	1000	14000	14000	14000	1000	3000	1000	12000	12000	10000	12000	15000	15000

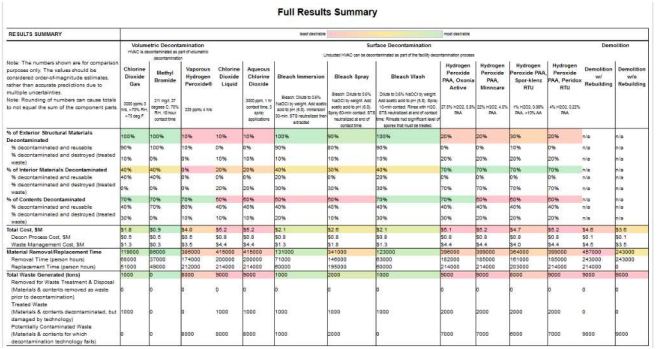
- **Important Infrastructure Facility #3**


Full Results Summary

RESULTS SUMMARY

Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Volumetric Decontamination (HVAC is decontaminable as part of volumetric decontamination)					Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)								Demolition	
	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray	Bleach Wash	Hydrogen Peroxide PNA, Oxonia Active	Hydrogen Peroxide PNA, Minncare	Hydrogen Peroxide PNA, Spor-klenz RTU	Hydrogen Peroxide PNA, Peridox RTU	Demolition w/ Rebuilding	Demolition w/o Rebuilding
	3000 ppmv 3 hrs, >70% RH, >75 deg F	21 mg/L 37 degrees C, 75% RH, 10 hour contact time	225 ppmv 4 hrs		3000 ppm 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Immerse 10-min. RTB neutralized then extracted	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	27.9% >2X2, 6.8% >4X4, >70% RH	2% >2X2, 4.9% >4X4	1% >2X2, 0.68% >4X4, >70% RH	4% >2X2, 0.22% >4X4		
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	20%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	80%	80%	10%	0%	0%	80%	80%	100%	70%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	80%	80%	10%	0%	0%	80%	80%	100%	70%	70%	70%	70%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	40%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	60%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	20%	10%	20%	n/a	n/a
Total Cost, $M	$1.3	$0.5	$0.3	$2.4	$2.4	$1.3	$1.5	$1.3	$2.4	$2.3	$2.5	$2.3	$2.5	$1.9
Decon Process Cost, $M	$0.3	$0.3	$0.3	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.1	$0.1
Waste Management Cost, $M	$0.7	$0.2	$1.8	$2.0	$2.0	$0.9	$1.0	$0.9	$2.0	$2.0	$2.1	$2.0	$2.4	$1.8
Material Removal/Replacement Time	95000	83000	226000	298000	298000	109000	204000	102000	229000	217000	215000	217000	276000	169000
Removal Time (person hours)	61000	41000	110000	126000	126000	64000	102000	62000	117000	115000	108000	115000	163000	153000
Replacement Time (person hours)	24000	22000	116000	112000	112000	41000	102000	41000	112000	102000	107000	102000	113000	0
Total Waste Generated (tons)	1000	0	4000	5000	5000	1000	1000	1000	5000	5000	4000	5000	5000	5000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	0	0	0	0	1000	1000	1000	1000	1000	1000	1000	1000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	0	0	4000	4000	4000	0	1000	0	4000	4000	3000	4000	5000	5000

- **Important Infrastructure Facility #4**


Full Results Summary

RESULTS SUMMARY

Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Volumetric Decontamination (HVAC is decontaminable as part of volumetric decontamination)					Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)								Demolition	
	Chlorine Dioxide Gas	Methyl Bromide	Vaporous Hydrogen Peroxide®	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide	Bleach Immersion	Bleach Spray	Bleach Wash	Hydrogen Peroxide PNA, Oxonia Active	Hydrogen Peroxide PNA, Minncare	Hydrogen Peroxide PNA, Spor-klenz RTU	Hydrogen Peroxide PNA, Peridox RTU	Demolition w/ Rebuilding	Demolition w/o Rebuilding
	3000 ppmv 3 hrs, >70% RH, >75 deg F	21 mg/L 37 degrees C, 75% RH, 10 hour contact time	225 ppmv 4 hrs		3000 ppm, 1 hr contact time, 3 spray applications	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Immerse 10-min. RTB neutralized then extracted	Bleach: Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	Dilute to 0.6% NaOCl to weight. Add waste acid to pH (5.8). Spray 10-min contact. Rinse with >5X RTB neutralized at end of contact time. Rinsate has significant level of agents that must be treated.	27.9% >2X2, 6.8% >4X4, >70% RH	2% >2X2, 4.9% >4X4	1% >2X2, 0.68% >4X4, >70% RH	4% >2X2, 0.22% >4X4		
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	20%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	40%	40%	0%	0%	0%	40%	40%	70%	70%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	40%	40%	0%	0%	0%	20%	20%	50%	50%	50%	50%	50%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	20%	20%	20%	20%	20%	20%	20%	n/a	n/a
% of Contents Decontaminated	70%	70%	70%	50%	50%	50%	50%	70%	50%	50%	50%	50%	n/a	n/a
% decontaminated and reusable	40%	70%	60%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	30%	0%	10%	10%	10%	10%	10%	30%	30%	20%	20%	20%	n/a	n/a
Total Cost, $M	$1.8	$0.9	$4.0	$5.2	$5.2	$2.1	$2.5	$2.1	$5.1	$5.2	$4.7	$5.2	$4.6	$3.6
Decon Process Cost, $M	$0.5	$0.5	$0.5	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.1	$0.1
Waste Management Cost, $M	$1.3	$0.3	$3.5	$4.4	$4.4	$1.3	$1.8	$1.3	$4.4	$4.4	$4.0	$4.4	$4.5	$3.5
Material Removal/Replacement Time	118000	96000	389000	416000	416000	131000	241000	132000	390000	399000	394000	399000	457000	343000
Removal Time (person hours)	56000	37000	174000	200000	200000	71000	145000	83000	182000	185000	181000	185000	243000	243000
Replacement Time (person hours)	51000	49000	212000	214000	214000	60000	96000	49000	208000	214000	203000	214000	214000	0
Total Waste Generated (tons)	1000	0	8000	9000	9000	1000	2000	1000	9000	9000	8000	9000	9000	9000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	1000	0	0	1000	1000	1000	1000	1000	2000	2000	2000	2000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	0	0	8000	8000	8000	1000	1000	0	7000	7000	6000	7000	9000	9000

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

- **Exercises – Important Infrastructure Facilities**
  - **Important Infrastructure Facility #1**
    - **Hospital**
    - **Type** = Hospital
    - **Large** = 18,500 m^2
    - **Number of Beds** = 95
    - **HVAC info** = Ducted, lined, less-accesible

RESULTS SUMMARY	least desirable → most desirable													
	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)					Surface Decontamination (HVAC will be very difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies)							Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas (3000 ppmv, 3 hrs, >70% RH, >75 deg F)	Methyl Bromide (211 mg/l, 37 degees C, 75% RH, 18 hour contact time)	Vaporous Hydrogen Peroxide® (225 ppmv, 4 hrs)	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide (3000 ppm, 1 hr contact time, 3 spray applications)	Bleach Immersion (Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then extracted)	Bleach Spray (Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.)	Bleach Wash (Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.)	Hydrogen Peroxide PAA, Oxonia Active (27.5% H2O2, 5.8% PAA)	Hydrogen Peroxide PAA, Minncare (22% H2O2, 4.5% PAA)	Hydrogen Peroxide PAA, Spor-klenz RTU (1% H2O2, 0.08% PAA, <10% AA)	Hydrogen Peroxide PAA, Peridox RTU (4% H2O2, 0.22% PAA)	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	20%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	50%	50%	0%	0%	0%	50%	50%	50%	70%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	50%	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	0%	0%	50%	50%	50%	70%	70%	70%	70%	n/a	n/a
% of Contents Decontaminated	80%	80%	80%	60%	60%	60%	60%	80%	80%	60%	60%	60%	n/a	n/a
% decontaminated and reusable	30%	80%	50%	30%	30%	30%	30%	30%	30%	30%	30%	30%	n/a	n/a
% decontaminated and destroyed (treated waste)	40%	0%	30%	30%	30%	30%	30%	40%	40%	30%	30%	30%	n/a	n/a
Total Cost, $M	$2.8	$1.2	$5.9	$8.0	$8.0	$3.4	$3.8	$3.4	$8.0	$8.0	$7.6	$8.0	$7.1	$5.3
Decon Process Cost, $M	$0.8	$0.8	$0.7	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$0.2	$0.2
Waste Management Cost, $M	$2.1	$0.4	$5.2	$6.9	$6.9	$2.3	$2.6	$2.3	$6.9	$6.9	$6.5	$6.9	$6.9	$5.2
Material Removal/Replacement Time	96000	58000	380000	403000	403000	126000	308000	124000	388000	390000	360000	390000	434000	226000
Removal Time (person hours)	53000	19000	176000	195000	195000	57000	126000	55000	180000	182000	162000	182000	226000	226000
Replacement Time (person hours)	43000	39000	204000	208000	208000	69000	183000	69000	208000	208000	198000	208000	208000	0
Total Waste Generated (tons)	2000	0	12000	14000	14000	2000	3000	2000	14000	14000	13000	14000	14000	14000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	1000	0	0	1000	1000	1000	1000	1000	2000	2000	2000	2000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	0	0	12000	12000	12000	1000	1000	0	11000	11000	10000	11000	14000	14000

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

- **Exercises – Important Infrastructure Facilities**
  - **Important Infrastructure Facility #2**
    - **Government Office**
    - **Type** = Walled Office Building
    - **Large** = 24,200 m^2
    - **Number of Occupants** = 947
    - **HVAC info** = Unducted

RESULTS SUMMARY — least desirable → most desirable

Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties.
Note: Rounding of numbers can cause totals to not equal the sum of the component parts.

	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)		Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)										Demolition	
	Chlorine Dioxide Gas 3000 ppmv, 3 hrs, >70% RH, >75 deg F	Methyl Bromide 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 4 hrs	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide 3000 ppm, 1 hr contact time, 3 spray applications	Bleach Immersion Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then extracted	Bleach Spray Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.	Bleach Wash Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	Hydrogen Peroxide PAA, Oxonia Active 27.5% H2O2, 5.8% PAA	Hydrogen Peroxide PAA, Minncare 22% H2O2, 4.5% PAA	Hydrogen Peroxide PAA, Spor-klenz RTU 1% H2O2, 0.08% PAA, <10% AA	Hydrogen Peroxide PAA, Peridox RTU 4% H2O2, 0.22% PAA	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$3.2	$1.6	$6.9	$9.1	$9.1	$4.2	$4.8	$4.2	$9.1	$9.1	$8.4	$9.1	$8.1	$6.3
Decon Process Cost, $M	$1.0	$1.0	$0.9	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$0.2	$0.2
Waste Management Cost, $M	$2.3	$0.6	$6.0	$7.6	$7.6	$2.8	$3.4	$2.8	$7.6	$7.6	$7.0	$7.6	$7.9	$6.1
Material Removal/Replacement Time	277000	205000	715000	776000	776000	342000	665000	334000	744000	753000	699000	753000	894000	529000
Removal Time (person hours)	199000	134000	356000	411000	411000	210000	332000	201000	379000	388000	353000	388000	529000	529000
Replacement Time (person hours)	78000	72000	358000	365000	365000	133000	333000	133000	365000	365000	347000	365000	365000	0
Total Waste Generated (tons)	2000	1000	14000	15000	15000	3000	4000	3000	15000	15000	14000	15000	15000	15000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	1000	0	0	1000	1000	2000	2000	2000	3000	3000	3000	3000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	1000	1000	14000	14000	14000	1000	3000	1000	12000	12000	10000	12000	15000	15000

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

- **Exercises – Important Infrastructure Facilities**
  - **Important Infrastructure Facility #3**
    - **US Consulate**
    - **Type** = Walled Office Building
    - **Medium** = 7,400 m^2
    - **Number of Occupants** = 291
    - **HVAC info** = Unducted

RESULTS SUMMARY	least desirable → most desirable													
	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)					Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)							Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas 3000 ppmv, 3 hrs, >70% RH, >75 deg F	Methyl Bromide 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppmv, 4 hrs	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide 3000 ppm, 1 hr contact time, 3 spray applications	Bleach Immersion Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then extracted	Bleach Spray Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.	Bleach Wash Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	Hydrogen Peroxide PAA, Oxonia Active 27.5% H2O2, 5.8% PAA	Hydrogen Peroxide PAA, Minncare 22% H2O2, 4.5% PAA	Hydrogen Peroxide PAA, Spor-klenz RTU 1% H2O2, 0.08% PAA, <10% AA	Hydrogen Peroxide PAA, Peridox RTU 4% H2O2, 0.22% PAA	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	90%	90%	10%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% decontaminated and reusable	80%	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	0%	0%	90%	90%	90%	100%	100%	100%	100%	n/a	n/a
% of Contents Decontaminated	60%	60%	60%	40%	40%	40%	40%	60%	60%	40%	40%	40%	n/a	n/a
% decontaminated and reusable	40%	60%	50%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	10%	10%	10%	10%	20%	20%	10%	10%	10%	n/a	n/a
Total Cost, $M	$1.0	$0.5	$2.1	$2.8	$2.8	$1.3	$1.5	$1.3	$2.8	$2.8	$2.6	$2.8	$2.5	$1.9
Decon Process Cost, $M	$0.3	$0.3	$0.3	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.1	$0.1
Waste Management Cost, $M	$0.7	$0.2	$1.8	$2.3	$2.3	$0.8	$1.0	$0.8	$2.3	$2.3	$2.1	$2.3	$2.4	$1.9
Material Removal/Replacement Time	85000	63000	220000	238000	238000	105000	204000	102000	229000	231000	215000	231000	275000	163000
Removal Time (person hours)	61000	41000	110000	126000	126000	64000	102000	62000	117000	119000	108000	119000	163000	163000
Replacement Time (person hours)	24000	22000	110000	112000	112000	41000	102000	41000	112000	112000	107000	112000	112000	0
Total Waste Generated (tons)	1000	0	4000	5000	5000	1000	1000	1000	5000	5000	4000	5000	5000	5000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	0	0	0	0	0	1000	1000	1000	1000	1000	1000	1000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	0	0	4000	4000	4000	0	1000	0	4000	4000	3000	4000	5000	5000

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

- **Exercises – Important Infrastructure Facilities**
  - **Important Infrastructure Facility #4**
    - **Adam Mickiewicz High School**
    - **Type** = High School
    - **Floor Area** = 12,600 m^2
    - **Number of Students**= 677
    - **HVAC info** = Unducted

RESULTS SUMMARY	least desirable → most desirable													
	Volumetric Decontamination (HVAC is decontaminated as part of volumetric decontamination)					Surface Decontamination (Unducted HVAC can be decontaminated as part of the facility decontamination process)							Demolition	
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. Note: Rounding of numbers can cause totals to not equal the sum of the component parts.	Chlorine Dioxide Gas 3000 ppm/, 3 hrs, >70% RH, >75 deg F	Methyl Bromide 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	Vaporous Hydrogen Peroxide® 225 ppm/, 4 hrs	Chlorine Dioxide Liquid	Aqueous Chlorine Dioxide 3000 ppm, 1 hr contact time, 3 spray applications	Bleach Immersion Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then extracted	Bleach Spray Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.	Bleach Wash Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated.	Hydrogen Peroxide PAA, Oxonia Active 27.5% H2O2, 5.8% PAA	Hydrogen Peroxide PAA, Minncare 22% H2O2, 4.5% PAA	Hydrogen Peroxide PAA, Spor-klenz RTU 1% H2O2, 0.08% PAA, <10% AA	Hydrogen Peroxide PAA, Peridox RTU 4% H2O2, 0.22% PAA	Demolition w/ Rebuilding	Demolition w/o Rebuilding
% of Exterior Structural Materials Decontaminated	100%	100%	10%	10%	10%	100%	90%	100%	20%	20%	30%	20%	n/a	n/a
% decontaminated and reusable	90%	100%	10%	0%	0%	90%	80%	90%	0%	0%	10%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	10%	10%	10%	10%	10%	20%	20%	20%	20%	n/a	n/a
% of Interior Materials Decontaminated	40%	40%	0%	20%	20%	40%	30%	40%	70%	70%	70%	70%	n/a	n/a
% decontaminated and reusable	40%	40%	0%	0%	0%	20%	0%	20%	0%	0%	0%	0%	n/a	n/a
% decontaminated and destroyed (treated waste)	0%	0%	0%	20%	20%	30%	30%	30%	70%	70%	70%	70%	n/a	n/a
% of Contents Decontaminated	70%	70%	70%	50%	50%	50%	50%	70%	70%	50%	50%	50%	n/a	n/a
% decontaminated and reusable	40%	70%	60%	40%	40%	40%	40%	40%	40%	40%	40%	40%	n/a	n/a
% decontaminated and destroyed (treated waste)	30%	0%	10%	10%	10%	20%	10%	30%	30%	20%	20%	20%	n/a	n/a
Total Cost, $M	$1.8	$0.9	$4.0	$5.2	$5.2	$2.1	$2.6	$2.1	$5.1	$5.2	$4.7	$5.2	$4.6	$3.6
Decon Process Cost, $M	$0.5	$0.5	$0.5	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.1	$0.1
Waste Management Cost, $M	$1.3	$0.3	$3.5	$4.4	$4.4	$1.3	$1.8	$1.3	$4.4	$4.4	$4.0	$4.4	$4.5	$3.5
Material Removal/Replacement Time	119000	86000	386000	415000	415000	131000	341000	123000	396000	399000	364000	399000	457000	243000
Removal Time (person hours)	68000	37000	174000	200000	200000	71000	146000	63000	182000	185000	161000	185000	243000	243000
Replacement Time (person hours)	51000	49000	212000	214000	214000	60000	195000	60000	214000	214000	203000	214000	214000	0
Total Waste Generated (tons)	1000	0	8000	9000	9000	1000	2000	1000	9000	9000	8000	9000	9000	9000
Removed for Waste Treatment & Disposal (Materials & contents removed as waste prior to decontamination)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treated Waste (Materials & contents decontaminated, but damaged by technology)	1000	0	0	1000	1000	1000	1000	1000	2000	2000	2000	2000	0	0
Potentially Contaminated Waste (Materials & contents for which decontamination technology fails)	0	0	8000	8000	8000	1000	2000	0	7000	7000	6000	7000	9000	9000

RESPONSE AND RECOVERY
Single-Building Decontamination Tool

- **Example – Fumigation vs. Surface Decontamination**
  - **Small office building contaminated only by foot traffic at entrances…**
  - **Fumigation still requires entire building**
  - **Surface decontamination only near entrances (e.g., 10% of floor area)**

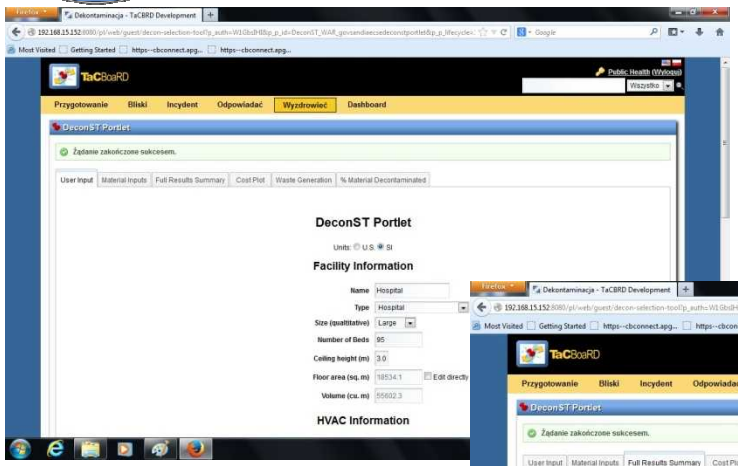
Fumigation of entire building

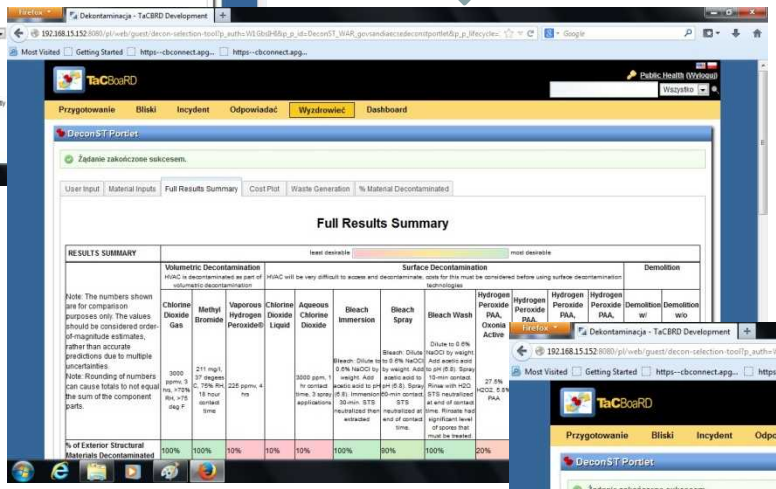
	Volumetric Decontamination			Demolition	
	HVAC is decontaminated as part of volumetric decontamination				
Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. *Note: Rounding of numbers can cause totals to not equal the sum of the component parts.*	**Chlorine Dioxide Gas** 3000 ppmv, 3 hrs, >70% RH, >75 deg F	**Methyl Bromide** 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	**Vaporous Hydrogen Peroxide®** 225 ppmv, 4 hrs	**Demolition w/ Materials Replacement** Demolition labor and materials for removing, disposing, and replacing building materials	**Demolition w/o Materials Replacement** Demolition labor and disposal of building materials
% of Exterior Structural Materials Decontaminated	**100%**	**100%**	**10%**	**n/a**	**n/a**
% decontaminated and reusable	90%	100%	10%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	n/a	n/a
% of Interior Materials Decontaminated	**90%**	**90%**	**10%**	**n/a**	**n/a**
% decontaminated and reusable	80%	90%	10%	n/a	n/a
% decontaminated and destroyed (treated waste)	10%	0%	0%	n/a	n/a
% of Contents Decontaminated	**60%**	**60%**	**60%**	**n/a**	**n/a**
% decontaminated and reusable	40%	60%	50%	n/a	n/a
% decontaminated and destroyed (treated waste)	20%	0%	10%	n/a	n/a
Total Cost, $k	**$2,150**	**$1,180**	**$3,020**	**$709.0**	**$571.0**
Decon Process Cost, $k	$790	$860	$720	$16.0	$16.0
Waste Management Cost, $k	$1,360	$310	$2,300	$693.0	$555.0
Material Removal/Replacement Time	**21,300**	**15,800**	**54,900**	**28,700**	**25,900**
Removal Time (person hours)	15,300	10,300	27,400	25,900	25,900
Replacement Time (person hours)	6,000	5,500	27,500	2,800	0
Total Waste Generated (tons)	**200**	**100**	**1,100**	**210**	**210**
Removed for Waste Treatment & Disposal *(Materials & contents removed as waste prior to decontamination)*	0	0	0	0	0
Treated Waste *(Materials & contents decontaminated, but damaged by technology)*	100	0	0	0	0
Potentially Contaminated Waste *(Materials & contents for which decontamination technology fails)*	100	100	1,000	210	210

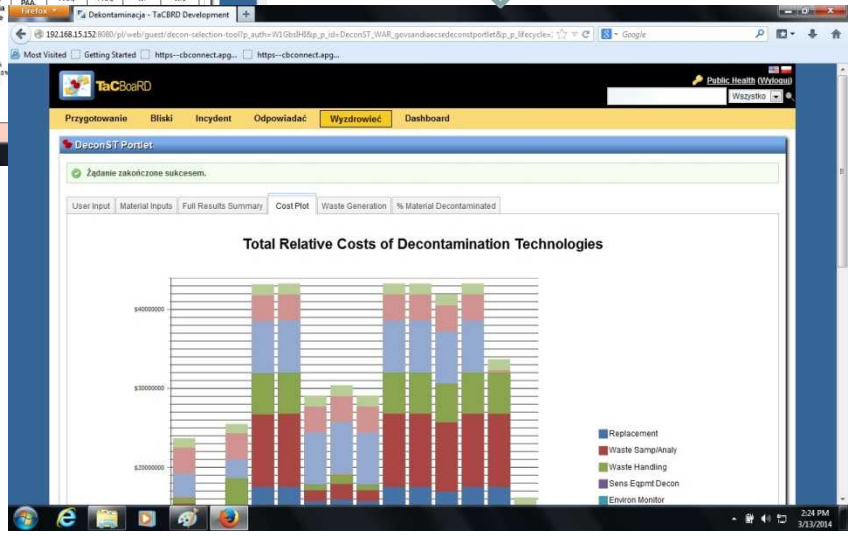
Surface decontamination only near entrances (10% of floor area)

Surface Decontamination								
HVAC will be very difficult to access and decontaminate; costs for this must be considered before using surface decontamination technologies								
Chlorine Dioxide Liquid	**Aqueous Chlorine Dioxide** 3000 ppm, 1 hr contact time, 3 spray applications	**Bleach Immersion** Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Immersion 30-min. STS neutralized then extracted	**Bleach Spray** Bleach: Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 60-min contact. STS neutralized at end of contact time.	**Bleach Wash** Dilute to 0.6% NaOCl by weight. Add acetic acid to pH (6.8). Spray 10-min contact. Rinse with H2O. STS neutralized at end of contact time. Rinsate had significant level of spores that must be treated	**Hydrogen Peroxide PAA, Oxonia Active** 27.5% H2O2, 5.8% PAA	**Hydrogen Peroxide PAA, Minncare** 22% H2O2, 4.5% PAA	**Hydrogen Peroxide PAA, Spor-klenz RTU** 1% H2O2, 0.08% PAA, <10% AA	**Hydrogen Peroxide PAA, Peridox RTU** 4% H2O2, 0.22% PAA
10%	**10%**	**100%**	**90%**	**100%**	**20%**	**20%**	**30%**	**20%**
0%	0%	90%	80%	90%	0%	0%	10%	0%
10%	10%	10%	10%	10%	20%	20%	20%	20%
0%	**0%**	**90%**	**90%**	**90%**	**100%**	**100%**	**100%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%
0%	0%	90%	90%	90%	100%	100%	100%	100%
40%	**40%**	**40%**	**40%**	**60%**	**60%**	**40%**	**40%**	**40%**
40%	40%	40%	40%	40%	40%	40%	40%	40%
10%	10%	10%	10%	20%	20%	10%	10%	10%
$663.0	**$664.0**	**$496.0**	**$517.0**	**$489.0**	**$656.0**	**$663.0**	**$634.0**	**$663.0**
$113.0	$113.0	$113.0	$114.0	$113.0	$113.0	$113.0	$113.0	$113.0
$550.0	$551.0	$383.0	$404.0	$377.0	$544.0	$551.0	$521.0	$551.0
19,700	**19,700**	**16,300**	**18,800**	**15,700**	**18,800**	**19,500**	**19,100**	**19,500**
16,900	16,900	15,300	16,300	14,600	16,000	16,700	16,400	16,700
2,800	2,800	1,000	2,600	1,000	2,800	2,800	2,700	2,800
170	**170**	**80**	**90**	**80**	**170**	**170**	**160**	**170**
0	0	0	0	0	0	0	0	0
20	20	20	20	30	50	30	30	30
160	160	60	70	40	130	140	130	140

RESPONSE AND RECOVERY
Single-Building Decontamination Tool







- **Single-Building Decontamination Tool**
  - **Input: Building Details**
  - **Output: Decontamination Choices with Associated Effectiveness & Costs**