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Restoration & Recovery Following the Release of a CBW Agent

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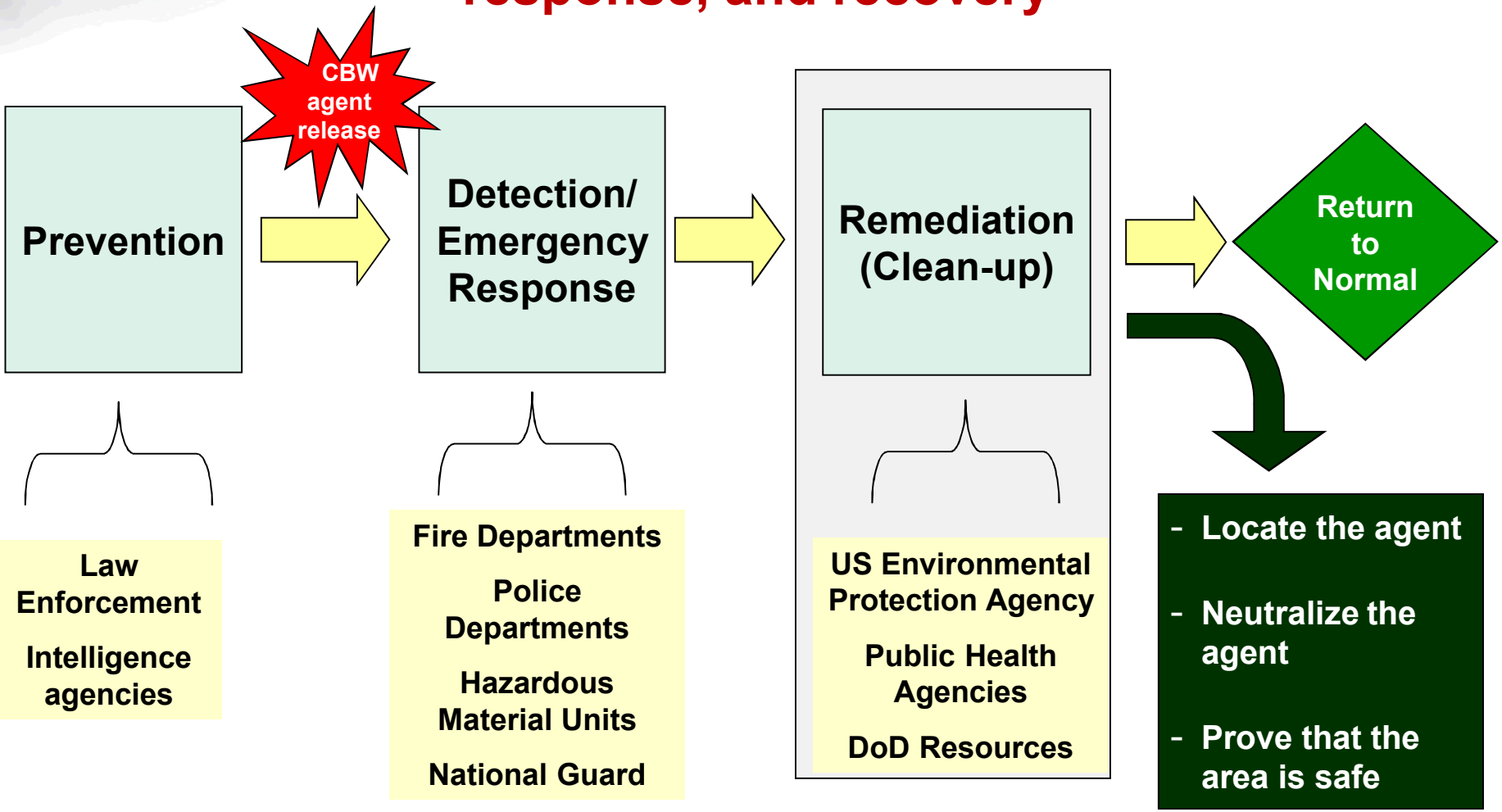
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

CBRN Work at Sandia is focused on prevention, response, and recovery



Our work is focused on remediation (clean-up) following a release of a CBW agent

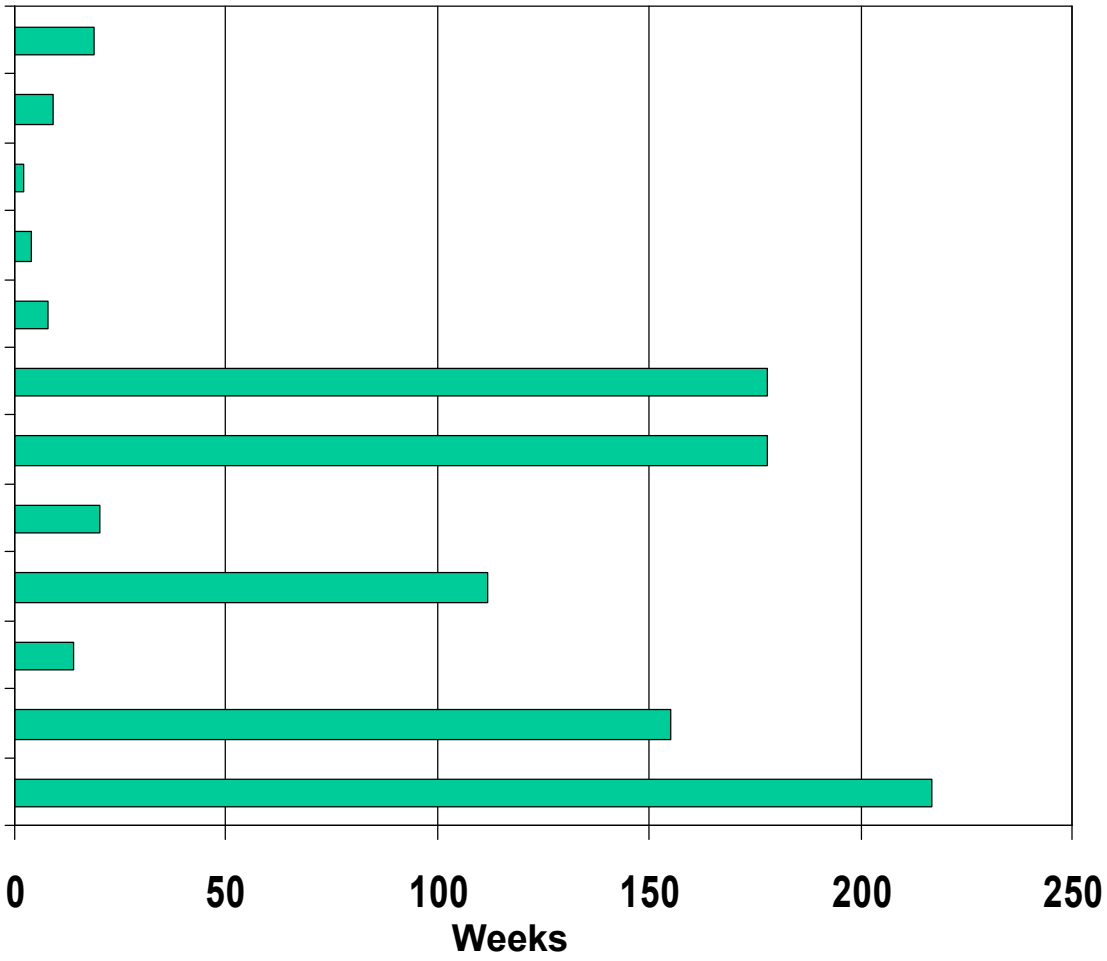
National response to the 2001 anthrax incidents was costly and time consuming

- Postal facilities, Senate buildings, and news organizations were contaminated
- Very little experience decontaminating large indoor facilities
- CDC reports that over 125,000 samples were tested at LRN laboratories costing $25-30M
- Many facilities were closed for years and restored at great cost
  - Capitol Hill (4 mo, $42M)
  - Brentwood (26 mo, $130M)
  - US Postal Facilities (3+ yr, $800M)

The need to improve the end-to-end remediation process was evident

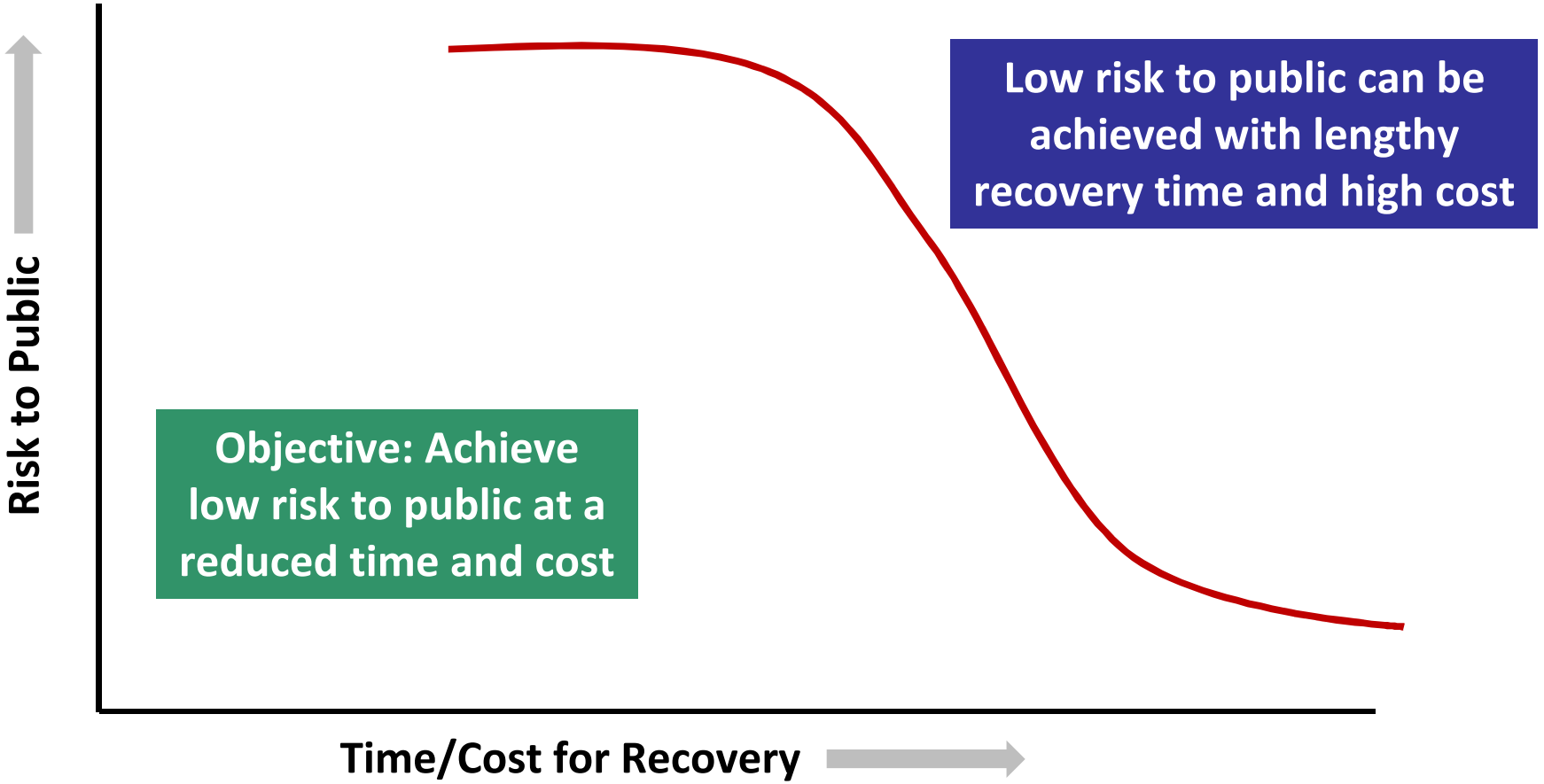
The lengthy recovery periods following the 2001 anthrax incidents have been the primary motivation for our work

State	Facility	Time
NY	Morgan	19 wk
NY	NBC	9 wk
NY	ABC	2 wk
NY	CBS	<4 wk
NY	NY Post	8 wk
NJ	Trenton	178 wk
VA	DOS	178 wk
MD	DOJ Mail Room	20 wk
DC	Brentwood	112 wk
DC	Hart	14 wk
DC	GSA 410	155 wk
FL	AMI	>217 wk

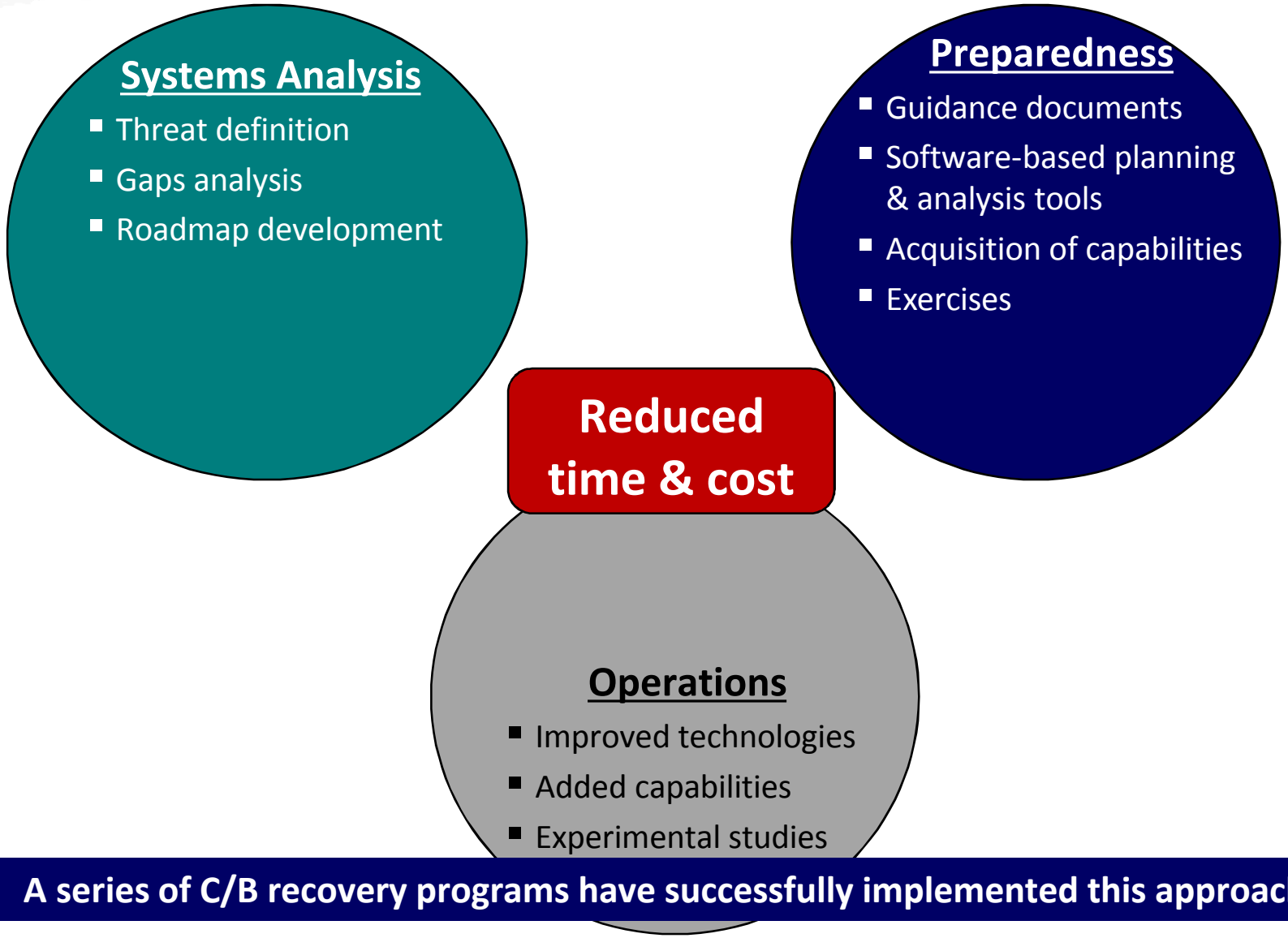


Make recovery better and faster to minimize economic damage while protecting public health

The overall objective for recovery is to minimize the risk to the public



Enhanced recovery can only be achieved through a systems approach



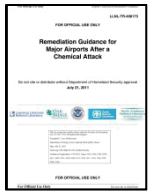
A series of C/B recovery programs have successfully implemented this approach

Sandia has developed detailed guidance for decontamination of critical infrastructure for chemical and biological warfare agents

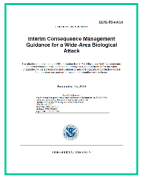
HOMELAND SECURITY

Bio Agent in Airport

Chemical Agent in Airport



Many of these processes & procedures can be applied to military scenarios



Wide Area Bio Agent Release

TaCBRD (DoD Assets)

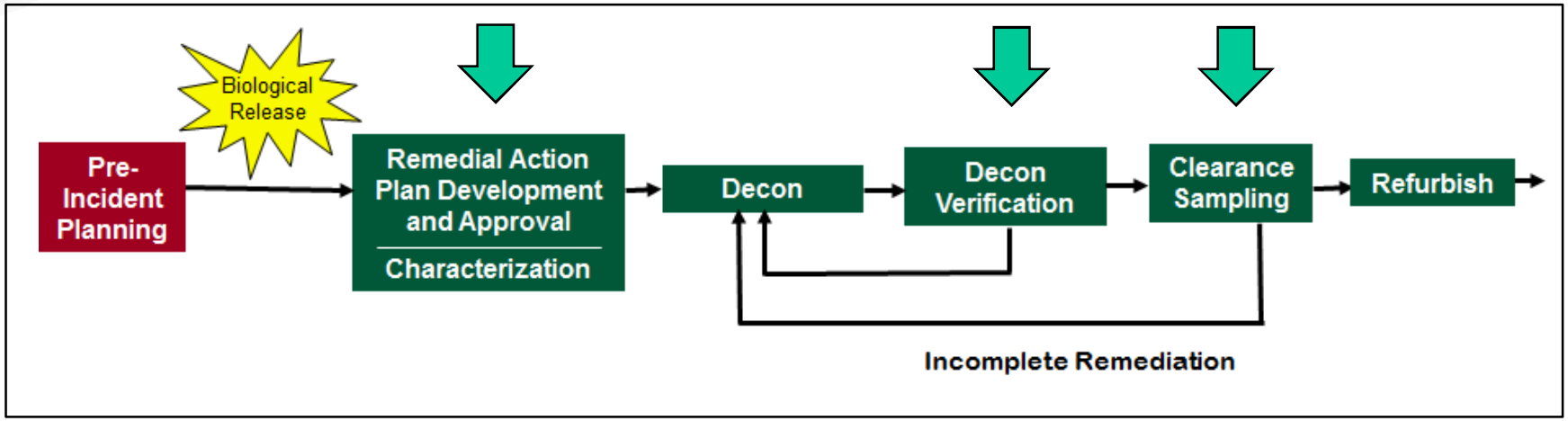
Wide Area CBRN Release

Chemical Agent in Subway

Bio Agent in Subway

2003 **2007** **2011** **2013** **2017**

The overall recovery is very complex



Sampling and analysis is a significant part of the remediation process – improved processes are needed

Currently – most sampling and analysis is conducted by wipe or vacuum sampling followed by PCR or culturing

Sampling Approach

- A three-tier sampling approach has been recommended for characterization
- Areas of interest are subdivided into zones
- Each zone is evaluated for potential contamination
  - If the zone is likely to be highly contaminated, move directly to decontamination, unless sampling is necessary to optimize the decon process
  - If the zone is likely not contaminated, perform confirmatory sampling to limit further work
  - If the zone contamination is uncertain, perform sampling to define nature of contamination

Clearance Sampling

- After decontamination there is a need to confirm the efficacy of the cleanup process through sampling
- Three approaches have been used to plan the location and number of samples needed for clearance sampling
  - Judgmental sampling – expert judgment is used
  - Statistical/probability sampling – statistical algorithms are employed that allow the user to make confidence statements (e.g., 95% confidence that 99% of the area is clean)
  - Hybrid sampling – Bayesian statistical methods are employed that allow the user to make statements about prior beliefs, thereby reducing the number of samples required for a given confidence goal

Clearance Sampling

- The GAO (2005) criticized the 2001 anthrax letter attack response to clearance sampling because judgmental sampling was employed, from which no confidence statements can be made
- Statistical/probability methods will result in large numbers of samples being collected, resulting in considerable time and cost, thereby stressing laboratory analysis capacity
- Real-time or near real-time detectors or sensors could save considerable time and cost, but would need appropriate **detection limits** and favorable **false positive/negative rate** performance

Clearance Sampling

- Detection limits would need to be consistent with conservative risk-based thresholds for soil, water and air
  - For radiological constituents, Preliminary Remediation Goals (PRGs) have been developed by EPA, and site-specific PRGs can be calculated with an EPA tool (http://epa-prgs.ornl.gov/radionuclides/)
  - For chemicals, EPA has developed Risk-Based Remediation Goals (RBRG) for 54 chemicals for soil and groundwater (http://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/waste/guide_ref/files/gme.pdf)

Clearance Sampling

- In addition, for chemicals, EPA has developed risk-based Provisional Advisory Levels (PALs) for air and drinking water (http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=500613)

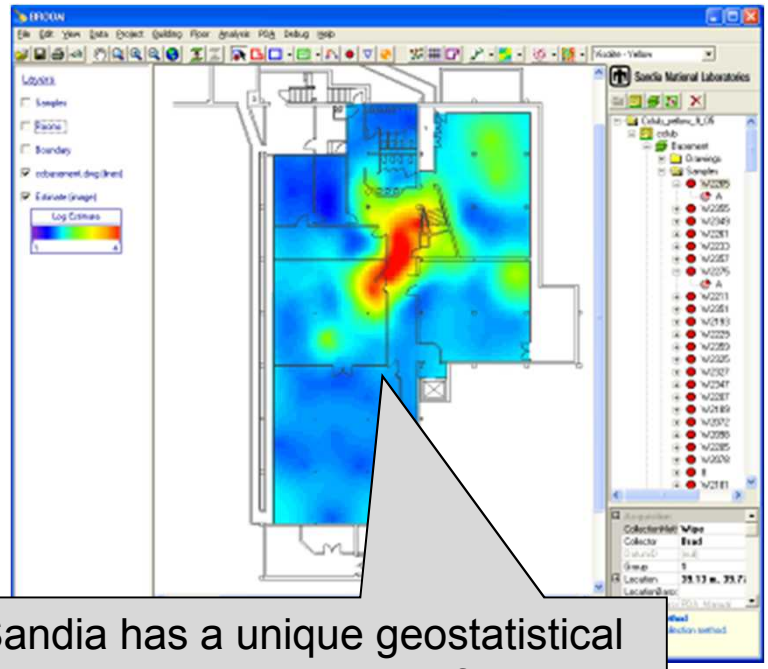
Clearance Sampling

- Arguably, one of the most devastating releases of a weapon of mass destruction (WMD) would be Bacillus anthracis (Ba) (i.e., anthrax)
- The EPA has not developed a risk-based cleanup threshold for anthrax, due to the lack of epidemiology data
- The defacto cleanup standard for anthrax is currently “no culturable growth” from the laboratory analysis of a surface sample
- The laboratory detection limit is currently on the order of 20 anthrax spores per sample
- Based on numerous surrogate release tests that SNL has participated in, detectors or sensors used for characterization would need to span a range from 20 spores/ft^2 to 10^8 spores/ft^2on a surface

Mapping Spatial Variability

- SNL has a decision support tool called SESSA that aids with sampling design, sample collection, data management, and data analysis
- The tool uses geostatistical methods that explicitly account for spatial variability and spatial correlation of the data, traditional statistical methods do not
- These methods can quantify uncertainty and variability in the distribution of contamination
- Maps showing the probability of exceeding a specified concentration can also be made with geostatistics
- Detectors or sensors could facilitate more rapid situational awareness with this tool

Expected Value Map



Sandia has a unique geostatistical technique that accounts for walls and doorways

Maps can be produced within minutes of the data uploads for real-time situational awareness