Sandia National Laboratories

SAND2010-7806C

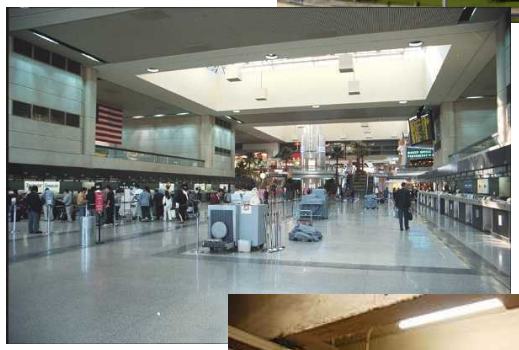
Simulation and Analysis of Facility Remediation: An Overview of the RESTORe Tool

Mark D. Tucker, Ph.D.
Donna M. Edwards, Ph.D.
Sandia National Laboratories
Phone: 505-844-7264
Email: mdtucke@sandia.gov

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

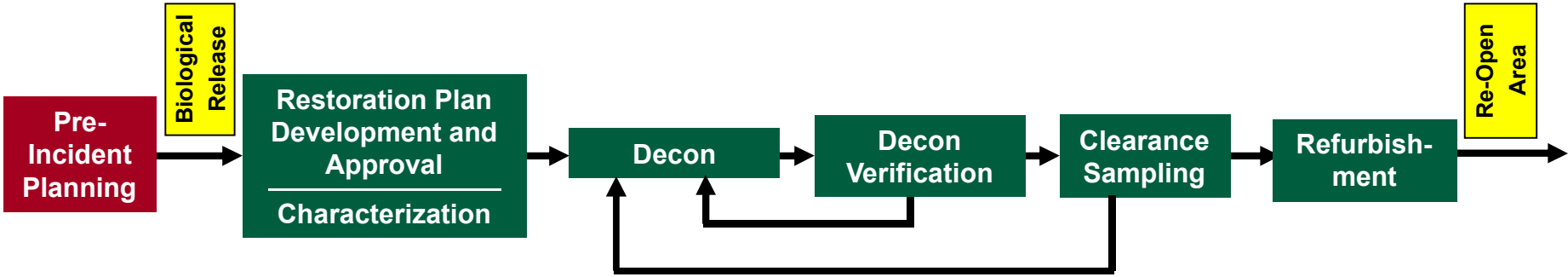
Presentation Outline

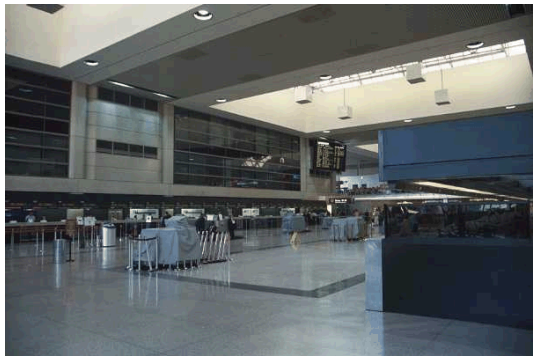
- Background
- Overview of the RESTORe Process Simulation Tool
- Case Study
- Summary



RESTORe: Resource Estimation and Scheduling Tool for Optimized Recovery

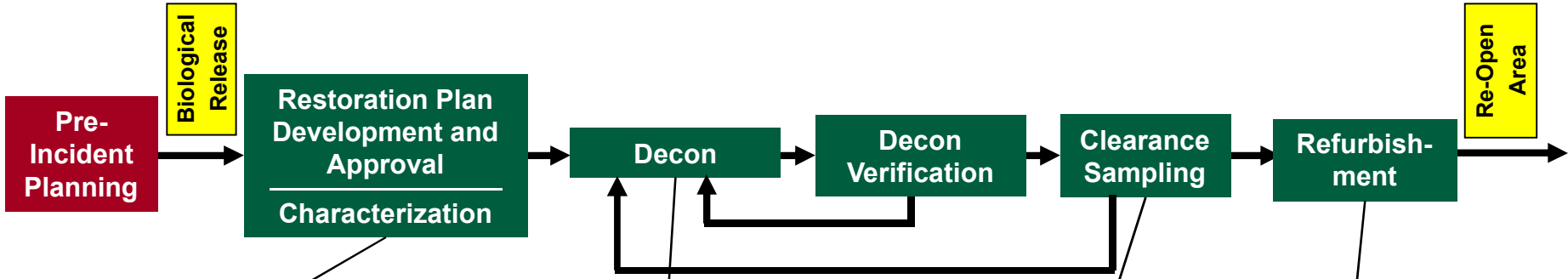
The remediation of a facility following the release of a chemical or biological agent is a complex process…





Reference: DHS/USEPA Remediation Guidance for Major Airports after a Bioterrorist Attack, 2007

The remediation of a facility following the release of a chemical or biological agent is a complex process…



- Detailed characterization of chemical agent
- Characterization of affected site
- Site containment
- Continue risk communication
- Environmental sampling and analysis
- Initial risk assessment
- Clearance goals

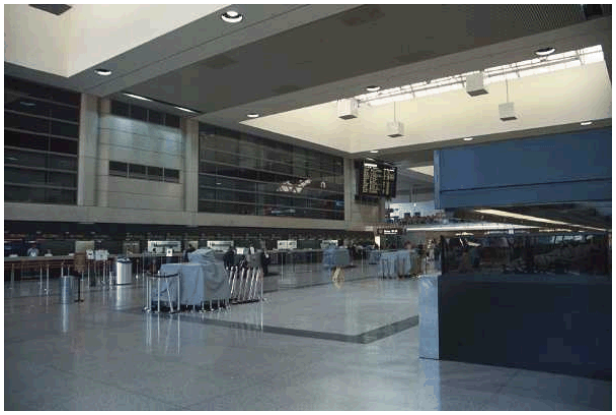
- Worker health and safety
- Source reduction
- Decontamination strategy
- Remediation Action Plan
- Site preparation
- Waste disposal
- Decontamination of sites, items, or both
- Verification of decon parameters

- Clearance sampling and analysis
- Clearance decision

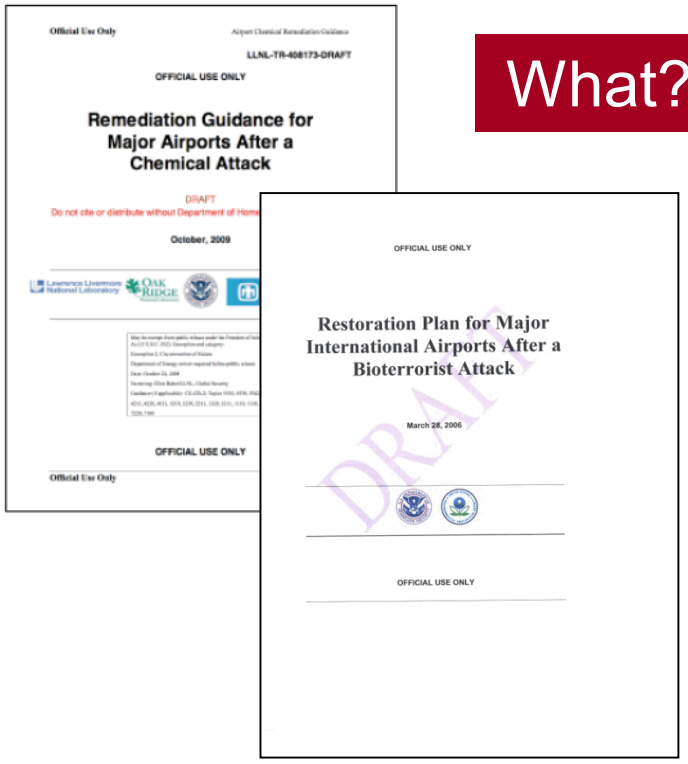
- Renovation
- Reoccupation decision
- Long-term environmental and public health monitoring

Effective planning for remediation will include both technical issues and more traditional project management issues

- Large open spaces and confined spaces
- Sensitive equipment essential for operations
- Many types of construction materials
- Wide range of decontamination and remediation challenges
- Remediation will include many complex activities
  - Sampling
  - Analysis
  - Decon (fumigation, surface removal, etc.)
  - Waste
  - Refurbishment
- Will involve the coordination and optimal use of many types of resources

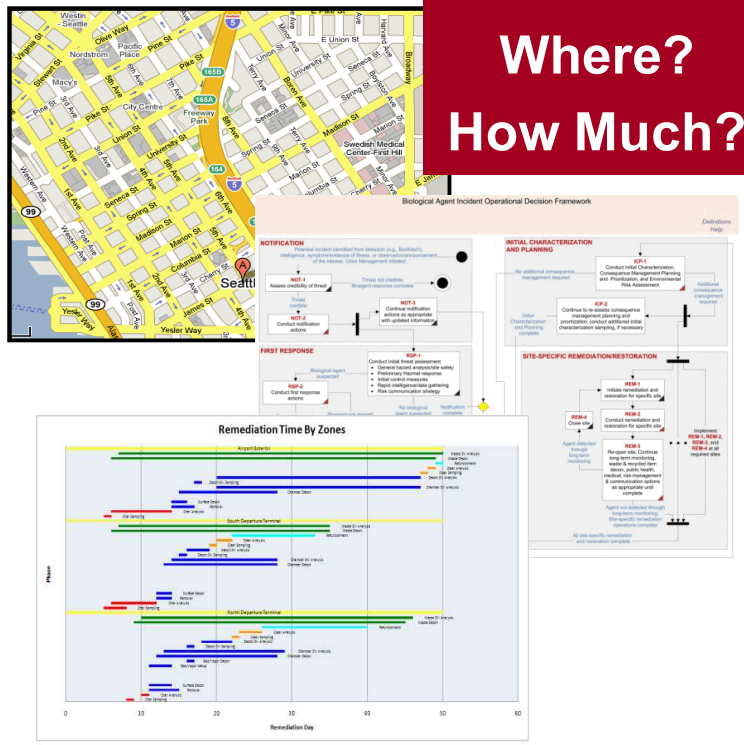


A method is needed to effectively plan for remediation events in facilities



What?

When?
Where?
How Much?

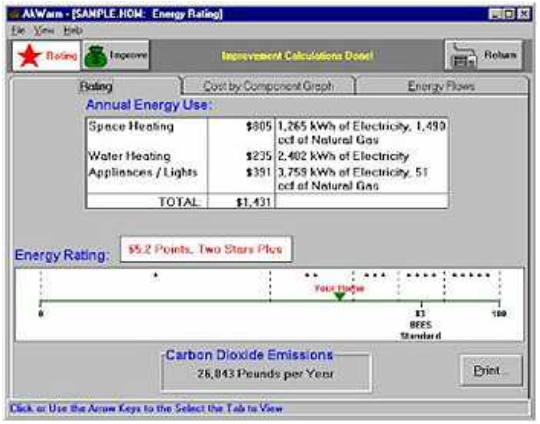


Guidance documents provide general information to plan remediation events

Decision support systems and/or simulation tools can be used for detailed planning for remediation events

Simulation tools are commonly used to better understand and make decisions about complex processes

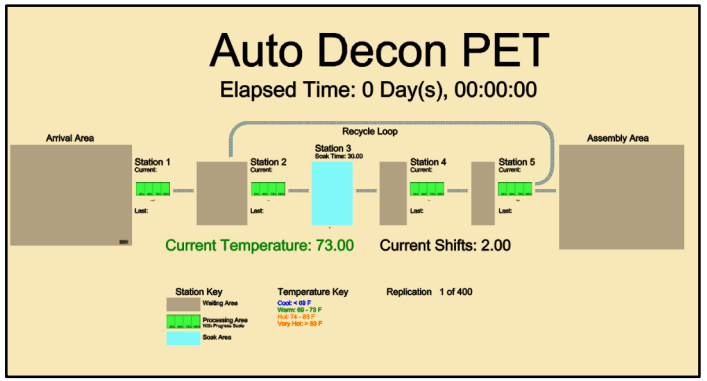
Manufacturing Process Simulation Tools (NIST)



AKWarm – Building Energy Use (Alaska Housing Finance Corporation)

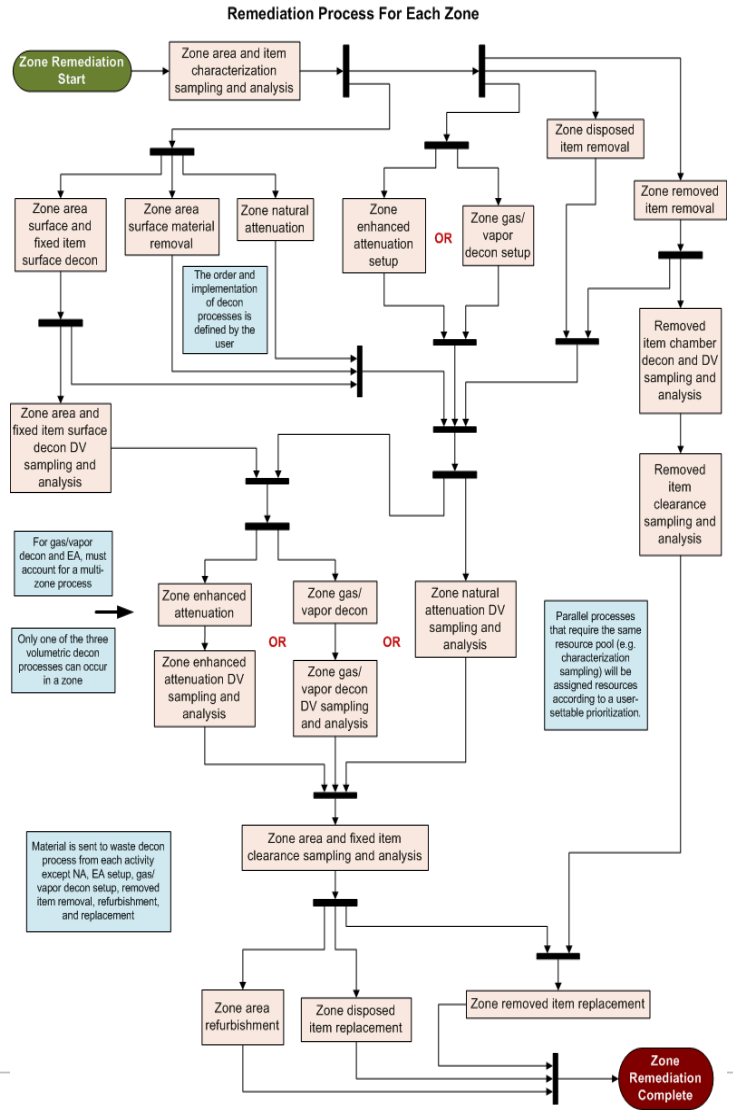
WaterAide™

WaterAide – Evaluates water saving opportunities (Energy New England)



PET – Evaluates DoD vehicle decon processes (Sandia National Laboratories)

Facility remediation is also a complex process that can be planned with the assistance of a simulation tool



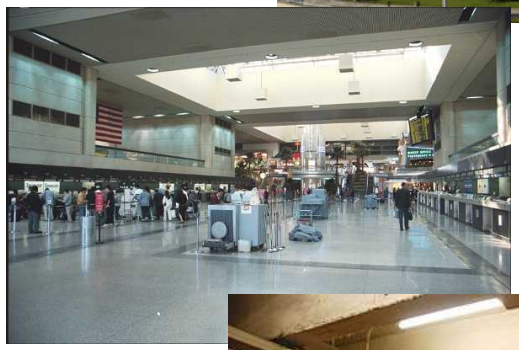
The complex remediation process logic is implemented in RESTORe

The remediation logic is flexible and can be changed (to some degree) by the user

RESTORe was developed as part of the DHS S&T-funded Chemical Restoration OTD project

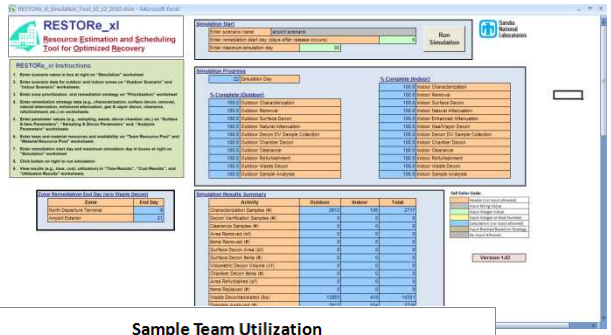
Presentation Outline

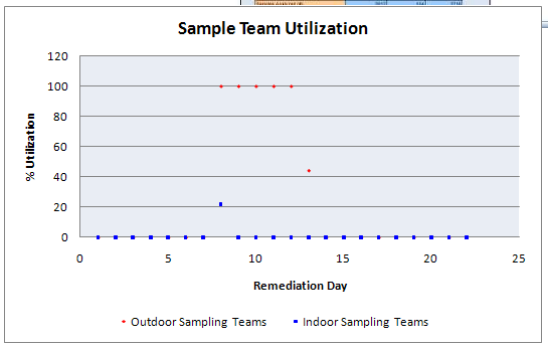
- Background
- Overview of the RESTORe Process Simulation Tool
- Case Study
- Summary



Features of the RESTORe Process Simulation Tool

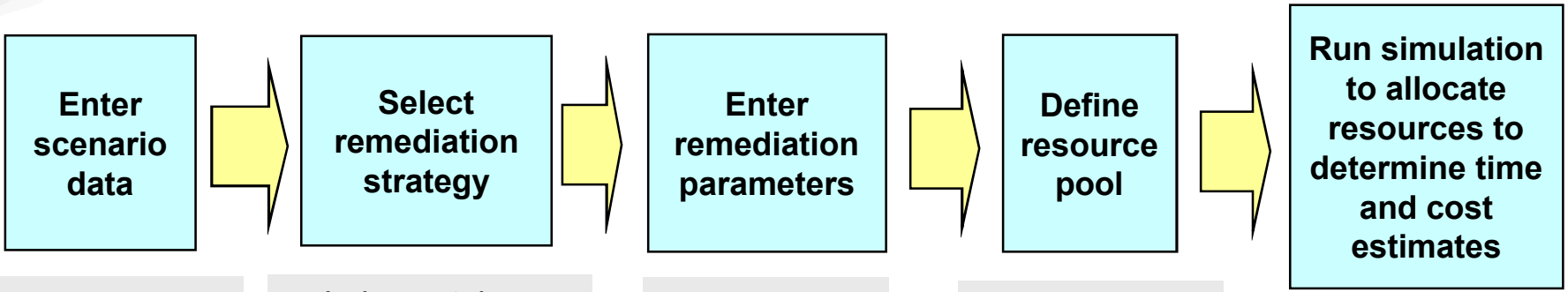
- *Scenario Setup*
  - Define up to 36 indoor zones and 36 outdoor zones
  - Define floor, wall, ceiling areas, zone volume, and number of items
  - Addresses both chemical or biological remediation
- *Multiple Remediation Phases*
  - Characterization
  - Decontamination
  - Clearance
  - Refurbishment
  - Waste Handling
  - Laboratory Analysis
- *Dynamic Resource Allocation*
  - Users define availability of resources
  - Resources are allocated based on user prioritization of zones and processes
- *Software Overview*
  - Current version runs in Microsoft Excel 2007
  - Process logic was developed using PowerSim™





The objective of RESTORe is to provide information to enable better decision making

Steps to run a RESTORe simulation and analysis



- Facility size
- Facility materials
- Items in facility
- Indoor and outdoor zones

- Judgmental vs. statistical sampling
- Active decon vs. natural attenuation
- Active decon vs. removal
- Prioritization of zones and activities

- Sample collection rates
- Decontamination rates
- Laboratory analysis rates

- Sample collection teams
- Decon equipment
- Laboratory sample analyses

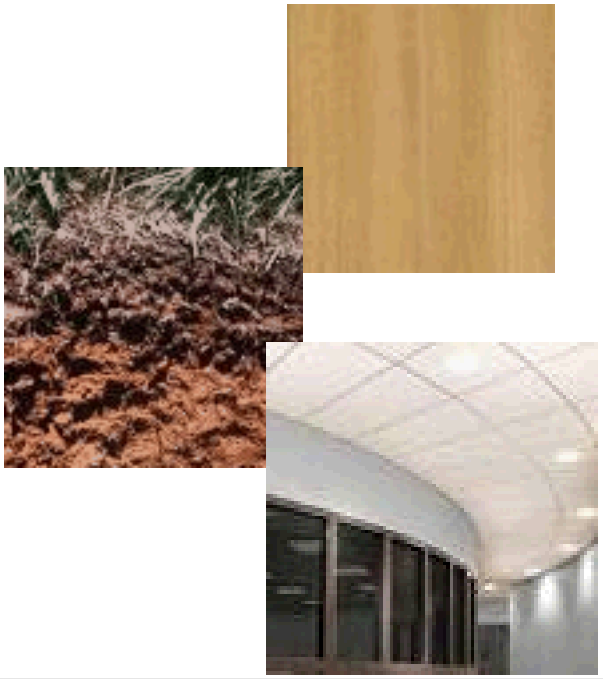
Automated

Information/data is used from many sources such as facility drawings, inventories, VSP, BROOM, etc.

Vary resources, resource allocations, and remediation strategies and to analyze and optimize the recovery process

The first step is to enter scenario data

- Area and volume of the contaminated facility
- Surface coverings in the facility
  - For floors, walls, and ceilings (indoor)
    - Carpet
    - Tile
  - For ground, walls, and roofs (outdoor)
    - Soil
    - Asphalt
- Definition of zones
  - Up to 36 indoor and 36 outdoor zones can be defined



The second step is to define a remediation strategy

- Define remediation processes that will be used
  - Characterization/Clearance
    - Number of samples
    - Types of samples
  - Decontamination
    - Surface decon
    - Removal
    - Natural attenuation
    - Volumetric decon (e.g., gas/vapor)
    - Chamber decon
  - Refurbishment
  - Waste decon
  - Laboratory analysis
- Define the order of decon processes
  - e.g., removal before surface decon, etc.
- Define priority of zones

The next step is to enter remediation parameters

Sampling & Analysis

- Sampling rate (samples/hr/team) for surface, bulk, and real-time samples
- Cost of samples ($/sample) for surface, bulk, and real-time samples
- Labor rate ($/hr) for sampling team members
- Laboratory analysis rate (samples/hr) for each sample type

Decontamination

- Surface decon rate (sf/hr/team)
- Cost of decontaminant ($/gal)
- Removal rate for each material (sf/hr/team)
- Agent decay rates for each material (%/hr)
- Chamber decon rate (lb/hr/chamber)

Refurbishment

- Refurbishment rate for each material (sf/hr/team)
- Labor rate ($/hr) for refurbishment team members
- Replacement cost of each material ($/sf)

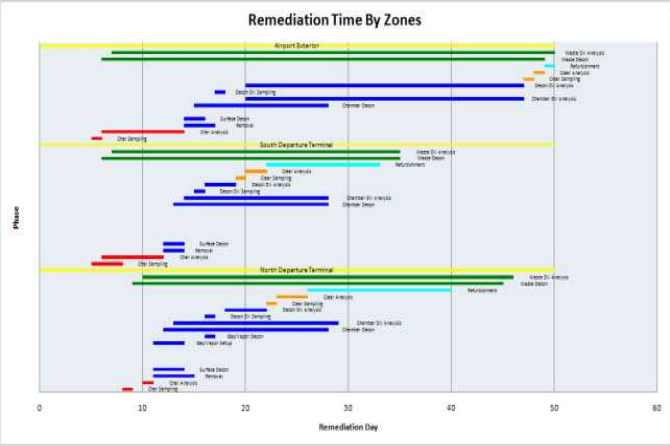
Several hundred parameters are entered into RESTORe – the accuracy of the analysis depends on the accuracy of the parameters

Then, a resource pool is established

- Sampling & Analysis
  - Indoor Sampling Teams
  - Outdoor Sampling Teams
  - Laboratory Analysis
- Decontamination
  - Surface Decon Teams
  - Removal Teams
  - Volumetric Decon Units
  - Decon Chambers
  - Waste Decon Units
- Refurbishment
  - Refurbishment Teams
- The amount and availability of the resources are defined by the user

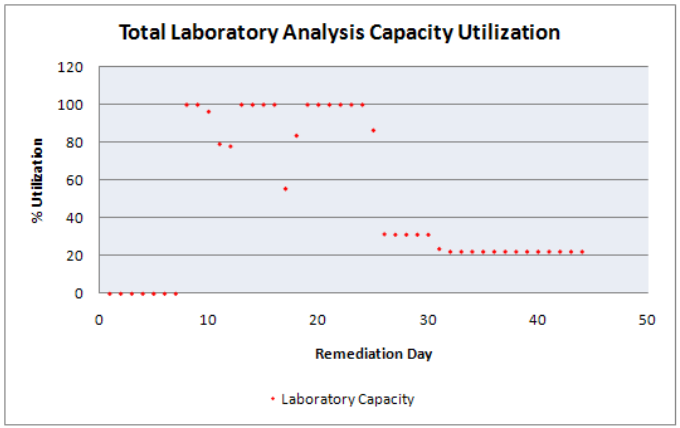
The resource pool includes both human and material resources

The final step is to run a remediation simulation and generate results



Remediation Timeline Plot

Cost Summary Plot



Resource Utilization Plots

Summary Table

Activity	Outdoor	Indoor	Total
Characterization Samples (#)	360	2159	2519
Decon Verification Samples (#)	4976	4878	9854
Clearance Samples (#)	260	1657	1917
Area Removed (sf)	325000	285150	610150
Items Removed (#)	650	4777	5427
Surface Decon Area (sf)	195000	114750	309750
Surface Decon Items (#)	239	1433	1672
Volumetric Decon Volume (cf)	0	2000000	2000000
Chamber Decon Items (#)	400	2388	2788
Area Refurbished (sf)	325000	285149	610149
Items Replaced (#)	650	4777	5427
Waste Decontaminated (lbs)	19535785	10767368	30303153

Summary Tables

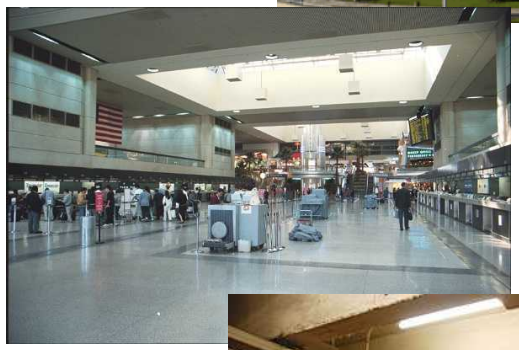
Example remediation calculation in RESTORe

		Resource Allocation (defined by algorithm)		Parameter (defined by user)		Parameter (defined by user)
Daily Samples Collected for Zone 1 Clearance	=	Sampling Teams Allocated to Zone 1 Clearance	x	Sample Collection Rate	x	Team Work Day
(Samples/Day)		(Teams)		(Samples/ Hr/Team)		(Hr/Day)

RESTORe makes thousands of simultaneous and inter-related calculations

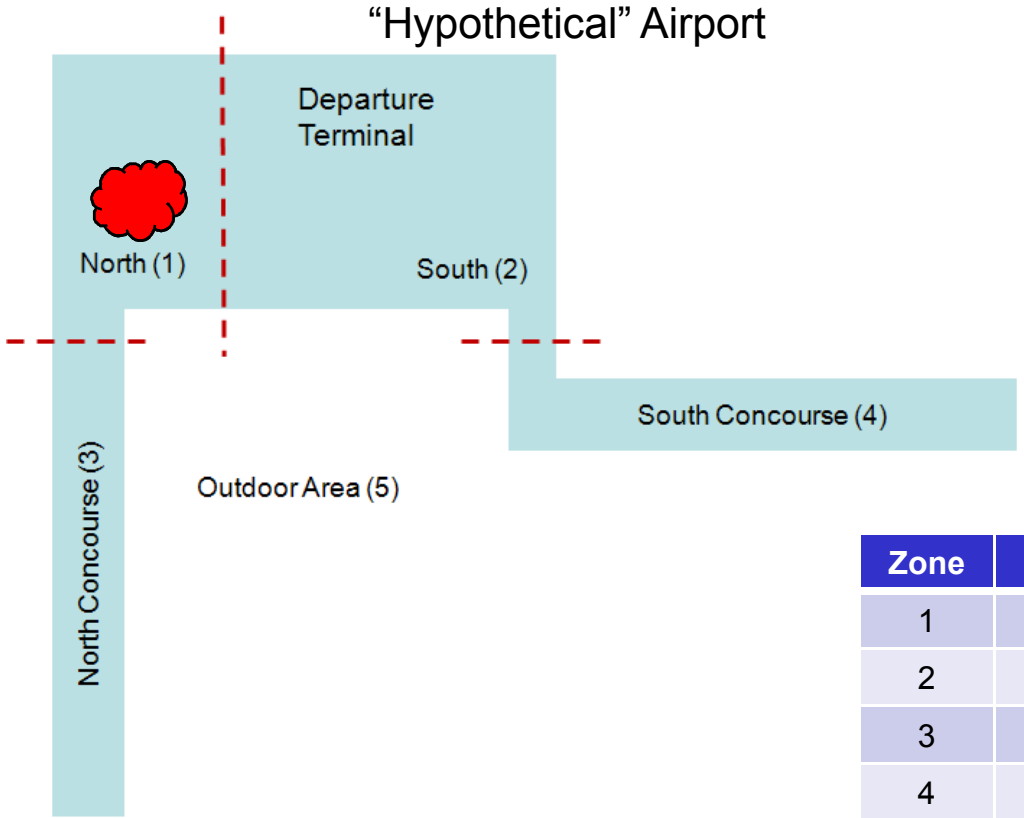
Presentation Outline

- Background
- Overview of the RESTORe Process Simulation Tool
- Case Study
- Summary



Airport Scenario Demo (CWA Release)

- Zone 1 – North Departure Terminal
- Zone 2 – South Departure Terminal
- Zone 3 – North Concourse
- Zone 4 – South Concourse
- Zone 5 – Outdoor Area



Scenario involves a release of Sarin on the departure level

Strategy

- Re-open the concourses as rapidly as possible
- Sample for clearance only in South Concourse
- Priority of Zones
  - South Concourse (Priority 1)
  - North Concourse (Priority 1)
  - South Departure Terminal (Priority 2)
  - North Departure Terminal (Priority 2)
  - Outdoor (Priority 3)

Zone	Floor/Ground	Walls	Ceiling
1	Tile	Wallboard, Glass	Ceiling Tile
2	Tile	Wallboard, Glass	Ceiling Tile
3	Tile, Carpet	Wallboard, Glass	Ceiling Tile
4	Tile, Carpet	Wallboard, Glass	Ceiling Tile
5	Concrete, Soil	-	-

Baseline Strategy

Characterization

	Characterization Sampling (Area)		Characterization Sampling (Items)
	Surface Samples	Bulk Samples	
Zone 1	25	7	138
Zone 2	984	328	220
Zone 3	348	116	119
Zone 4	0	0	0
Outdoor	100	400	160

From VSP

Decontamination/Refurbishment

	Decontamination					Refurbishment	
	Surface Decon (Bleach)	Gas Decon (mVHP®)	Removal of "Difficult to Decon" Surfaces	Removal of Items for Chamber Decon (mVHP®)	Removal of Items for Disposal	Replace Surfaces	Replace Items
Zone 1	✓	✓	✓	✓	✓	✓	✓
Zone 2	✓	✓	✓	✓	✓	✓	✓
Zone 3	✓		✓	✓	✓	✓	✓
Zone 4					✓		✓
Outdoor	✓		✓	✓	✓	✓	✓

Clearance

	Clearance Sampling (Area)		Clearance Sampling (Items)	
	Surface Samples	Bulk Samples	Fixed Items	Removed Items
Zone 1	492	164	138	69
Zone 2	197	66	220	110
Zone 3	70	23	119	60
Zone 4	434	145	0	119
Outdoor	65	200	80	40

Lab capacity: 1500 samples per week (GC/MS)

Alternative Strategy

Decision: Should the US EPA's mobile laboratory (PHILIS) be deployed?

Additional lab capacity: 700 samples per week (GC/MS)

Capability Insertion

PHILIS

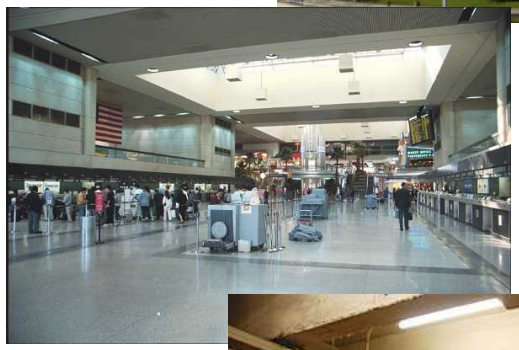
Comparison of the baseline and alternative remediation strategies using RESTORe

Zone	Baseline (Completion Day)	PHILIS (Completion Day)
Zone 1 (North Departure Terminal)	Day 60	Day 52
Zone 2 (South Departure Terminal)	Day 58	Day 50
Zone 3 (North Concourse)	Day 35	Day 33
Zone 4 (South Concourse)	Day 19	Day 18
Zone 5 (Outdoor)	Day 77	Day 57
Overall Reduction (days)	-	-20 days
Overall Reduction (%)	-	-33%
Interior Reduction (days)	-	-8 days
Interior Reduction (%)	-	-18%

Other strategies can also be evaluated using RESTORe including technology insertions (e.g., real-time sampling & and analysis) and resource insertions (e.g., more sampling teams)

Presentation Outline

- Background
- Overview of the RESTORe Process Simulation Tool
- Case Study
- Summary



Summary

- RESTORe enables detailed analyses of facility remediation
  - Time and cost estimates
  - Resource requirements
  - Analyses of alternative strategies
  - Identification of technology and capability gaps
- RESTORe was developed as part of the DHS S&T Chemical Restoration OTD project
  - Focused on remediation following the release of a chemical warfare agent or toxic industrial chemical
- RESTORe logic has been expanded to include analyses for biological remediation events
  - Potentially applicable to other recovery events (e.g., rad)
  - Addition of optimization algorithms is planned
- Current version runs in Microsoft Excel 2007
  - Excel worksheets are used as the user interface
  - Simulation code runs in the background
  - An enhanced user interface is being developed for a full coded version

RESTORe_xl
Resource Estimation and Scheduling Tool for Optimized Recovery