SAND2011-3122C

Homeland Security

Chemical Restoration Operational Technology Demonstration (OTD)
Midwest Airports Workshop

Chemical Restoration Tools Overview

Toolsets for Improved Response Planning for Chemical Incidents

ADVISER: Automated Decision Visualization and Information System for Emergency Response/Recovery
RESTORe: Resource Estimation and Scheduling Tool for Optimized Recovery

Mark Tucker
Donna Edwards

Sandia National Laboratories

Chemical Restoration Operational Technology Demonstration (OTD) Project Workshop

Acknowledgements

Sandia Development Team

SMEs -- Logic and Overall Design

Donna Edwards - RESTORe
Wayne Einfeld - PATH/AWARE
David Franco - PATH
Robert Knowlton - PATH/AWARE
Mark Tucker - RESTORe
Lynn Yang - PATH

Software Development

Donna Edwards - RESTORe
Mark Tucker - RESTORe
Kimberly Grommes - PATH/AWARE
Karim Mahrous - PATH
Brad Melton - PATH/AWARE

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Questions Asked by Decision Makers…

- **Following a wide-area release:**
  - Resources available to restore the area will be limited
  - Time to complete restoration will be lengthy, possibly years
- **Decision makers will want to know:**
  - How long will the cleanup take so that businesses will be functional again?
  - How much money and resources can the feds provide?
  - Where do those resources get applied?
  - If additional resources were available, could the restoration be done in less time?
  - What are the choke points in the process?

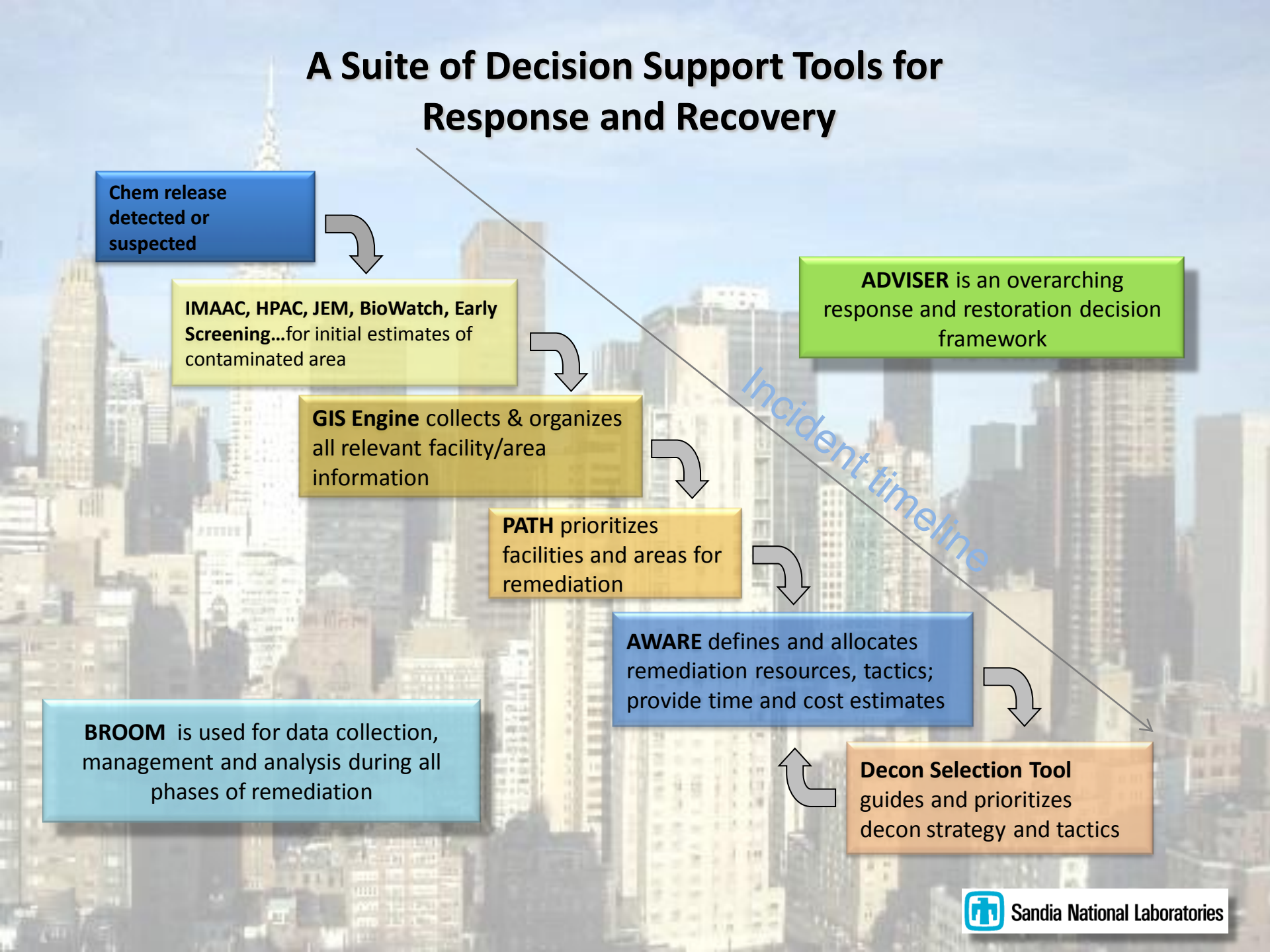
First Responders & Sampling

Laboratory Analysis

Decontamination

Decision support tools can provide increased efficiency and clarity to the restoration process

A Suite of Decision Support Tools for Response and Recovery



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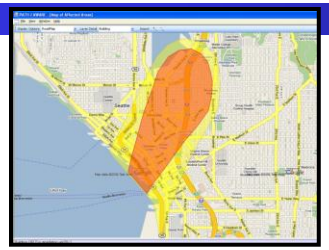
Bio release detected or suspected
IMAAC, HPAC, BioWatch, Early Screening…, for initial estimates of contaminated area
GIS Engine collects & organizes all relevant facility/area info
PATH prioritizes facilities and areas for remediation
AWARE and RESTORe define and allocate remediation resources, tactics; time and cost estimates
Decon Technology Selection Tool guides decon strategy/tactics
BROOM is used for data collection, management and analysis during all phases of remediation
ADVISER is an overarching response and restoration decision framework
PATH-AWARE
Overview

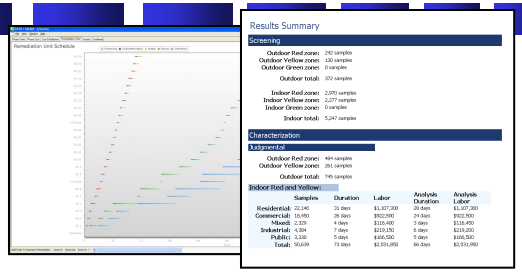
Integration of GIS Engine, PATH, and AWARE



Map Displays

Google maps

External Databases:
Local Tax, HSIP, HAZUS…



Timelines and Costs

GIS Engine

Facility/Area/Asset Database

AWARE

User-defined Scenario

PATH

Prioritized Asset List

User-defined Restoration Objectives

User-defined Remediation Resources

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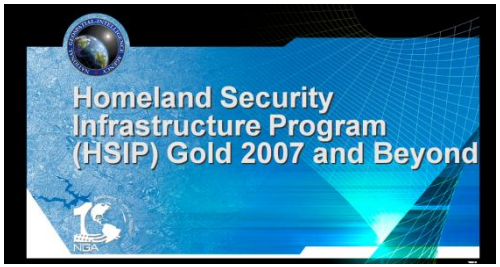
Asset and Facility Databases

- **King/Pierce County GIS (as a specific urban example…)**
  - Virtually all county-wide buildings and structures
  - Additional useful attributes (use description, assessed value, plot sizes, building footprints)
  - We have access to these databases -- similar access expected for other urban areas
- **DHS Homeland Security Infrastructure Program (HSIP)**
  - Geo-located critical assets and infrastructures
  - Gold and Freedom levels, restrictions on Gold level use
- **FEMA HAZUS-MH**
  - Residential and non-residential geo-located building inventories
  - Nationwide coverage
  - Transportation infrastructure is also included
- **Emporis**
  - US and Canadian cities
  - Major buildings (>5 floors) in database
  - Many key attributes (size, age, type of HVAC, use, floor space etc.)

KCGIS Center



EMPORIS RESEARCH

We have built GIS Engine interfaces to each of these databases

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PATH/AWARE Database Usage

PATH

HSIP Critical Infrastructure Data

- Hospitals
- Police Stations
- Fire Stations
- Electric Power
- Water and Wastewater Utilities
- etc.

Used to Prioritize Services and Assets

AWARE

Building Data

- Usage Type (e.g., residential, commercial, etc.)
- Number of Floors/Stories
- Indoor Area (e.g,, square footage)
- Construction Type
- Age
- etc.

Used to Calculate Restoration Timelines and Cost

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Example King Co. Building Data Record

King County

Assessor information for parcel number 1974700025

Taxpayer name	SEATTLE CITY OF	Parcel number	1974700025
Mailing address	PO BOX 34689 SEATTLE WA 98124	Tax Account number	197470002506
		Levy code	0010
		Jurisdiction	SEATTLE
		Present use	Art Gallery/Museum/Soc Srvc
		Appraised value	$112,287,700
Address(es) at this parcel	1301 3RD AVE 98101		

Legal description

DENNYS A A 2ND ADD LOTS 1 & 4-5-6 & 8 THRU 12 LESS PORS FOR 2ND & 3RD AVES TGW POR VAC ALLEY ADJ AS VAC BY CITY OF SEATTLE ORD NO 113486 LESS TRANSFERABLE DEVELOPMENT RIGHTS AS DESC IN DEED REC # 20040817001190 & 20060331000387

Sales/Quit Claims/Transfers

Sale date	Sale price	Buyer	Seller	Excise tax number	Recording number	Instrument type	Sale reason
12-14-2007	$0	1918 EIGHTH LLC	SEATTLE CITY OF	2324902	20071214002245	Special Warranty Deed	Other
08-10-2007	$0	EIGHT-EIGHTEEN STEWART LLC	SEATTLE CITY OF- OFFICE OF HOUSING	2303931	20070810001893	Special Warranty Deed	Other
06-07-2007	$527,835	TOUCHSTONE WEST 8TH BUILDING LLC	SEATTLE CITY OF -OFFICE OF HOUSING	2290469	20070612001953	Special Warranty Deed	Other
03-30-2006	$13,728	1000 FIRST AVE L L C	SEATTLE CITY OF	2196292	20060331000387	Special Warranty Deed	Other
08-13-2004	$0	1301 SECOND AVENUE LLC	SEATTLE CITY OF	2062963	20040817001190	Special Warranty Deed	Other
06-01-2000	$4,812,453	NATIONAL OFFICE PARTNERS L P	SEATTLE CITY OF/OFFICE OF HOUSING	1757421	20000606000210	Special Warranty Deed	Other
03-16-1995	$0	SEATTLE CITY OF	MARATHON U S REALTIES INC	1420096	199503160183	Warranty Deed	Other

Parcel description

Property name	Benaroya Hall	Plat name	DENNYS A A 2ND ADD	Water system	WATER DISTRICT
Property type	C - COMMERCIAL	Plat block	2	Sewer system	PUBLIC
Present use	Art Gallery/Museum/Soc Srvc	Plat lot	1 &	Access	PUBLIC
Lot area	63,180 sq. ft. (1.45 acres)	Q-S-T-R	SE-31-25-4	Street surface	PAVED

Commercial building description

Building	1 of 1	Building description	Benaroya Symphony Hall
Year built	1998	Predominant use	THEATER, LIVE STAGE (379)
Stories	6	Gross sq. ft.	284,100
Building quality	EXCELLENT	Net sq. ft.	284,100
Construction class	REINFORCED CONCRETE	Heating system	COMPLETE HVAC
Building shape	Very Irreg	Sprinklers	Y
		Elevators	Y

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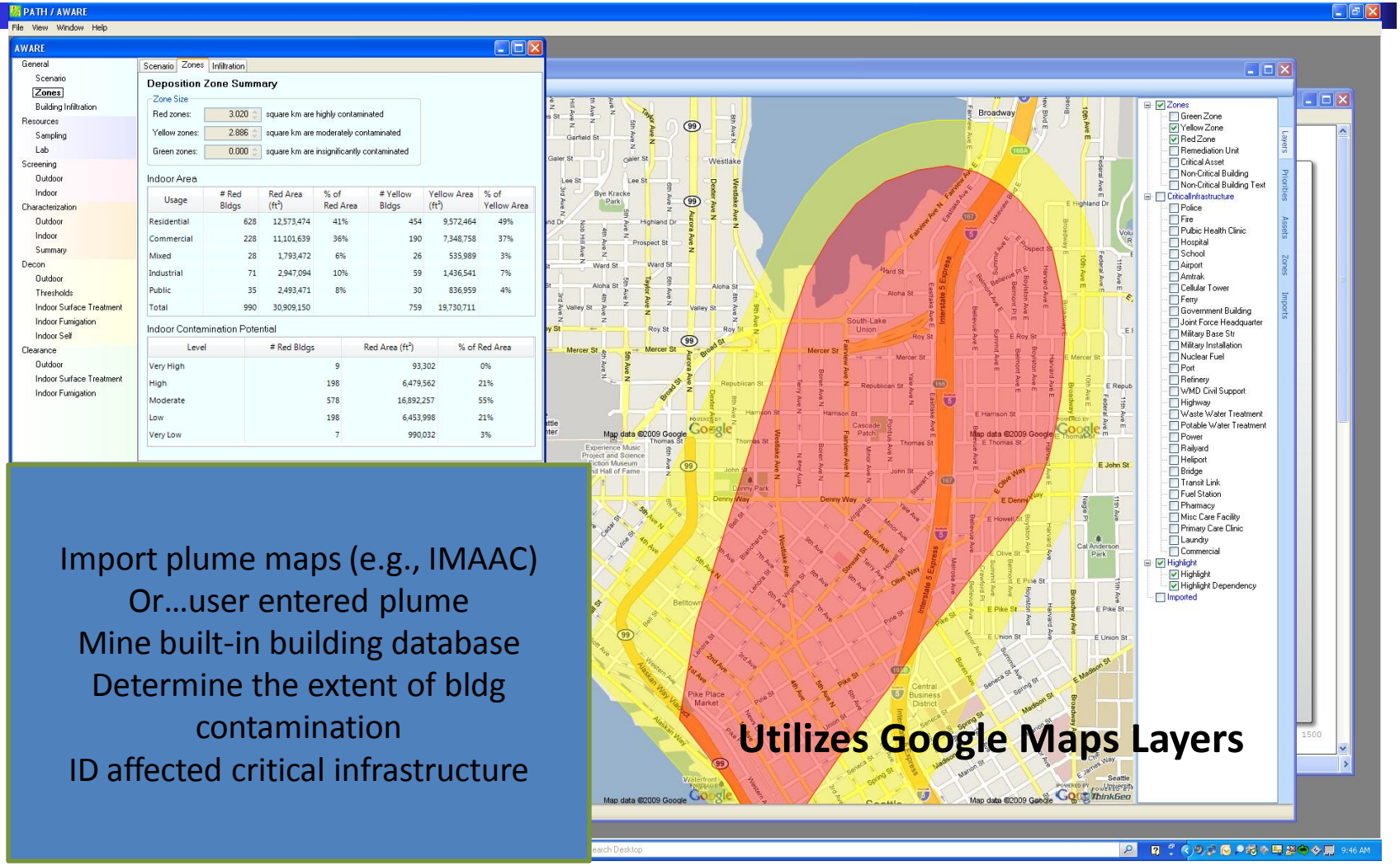
User Input: Scenario Description



Import plume maps (e.g., IMAAC)
Or…user entered plume
Mine built-in building database
Determine the extent of bldg contamination
ID affected critical infrastructure

Utilizes Google Maps Layers

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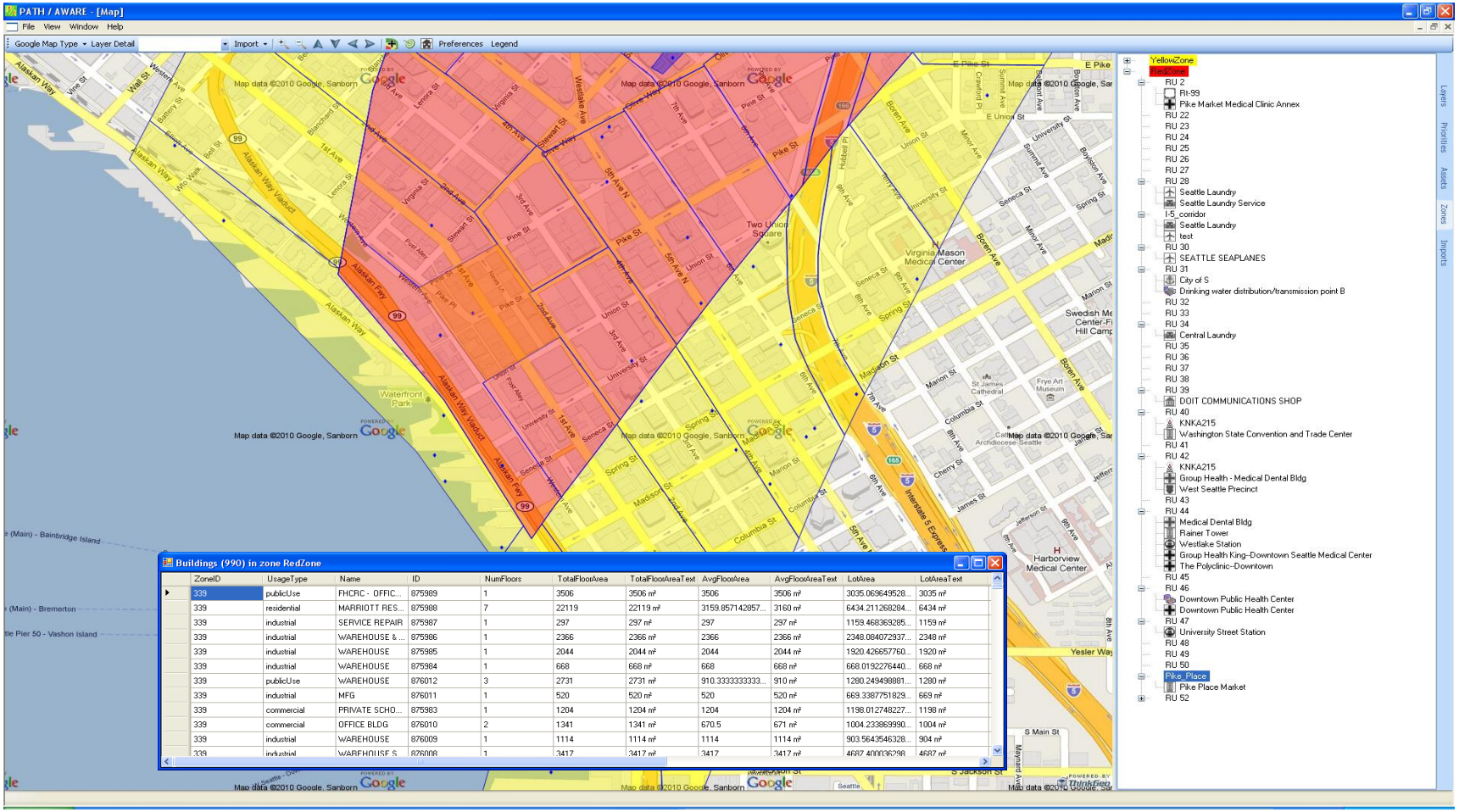
PATH/AWARE Output: Contaminated Facility Information



Why Prioritize Critical Assets?

- **Critical Assets** – provide vital function for some aspect of the nation/community
  - power, communication, public health, security…
- **Limited Restoration Resources** – capacity not easily scaled up
  - characterization, decontamination, clearance, waste
- **Multiple Stakeholders** - competing interests for limited restoration resources
  - public health, private sector, law enforcement…

The PATH tool provides an objective starting point for ranking assets in a multi-stakeholder environment

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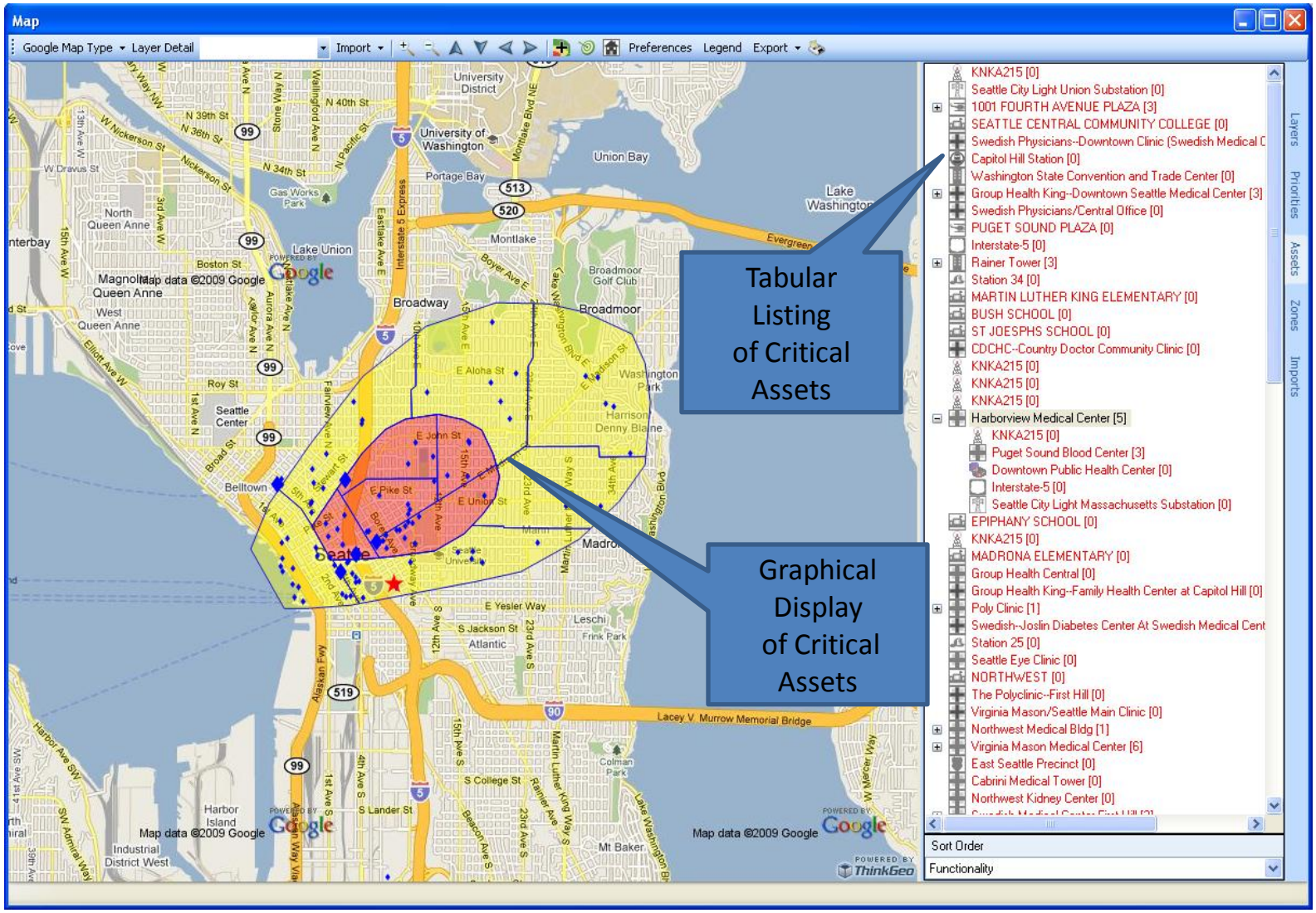
PATH: Identify and Visualize Critical Assets



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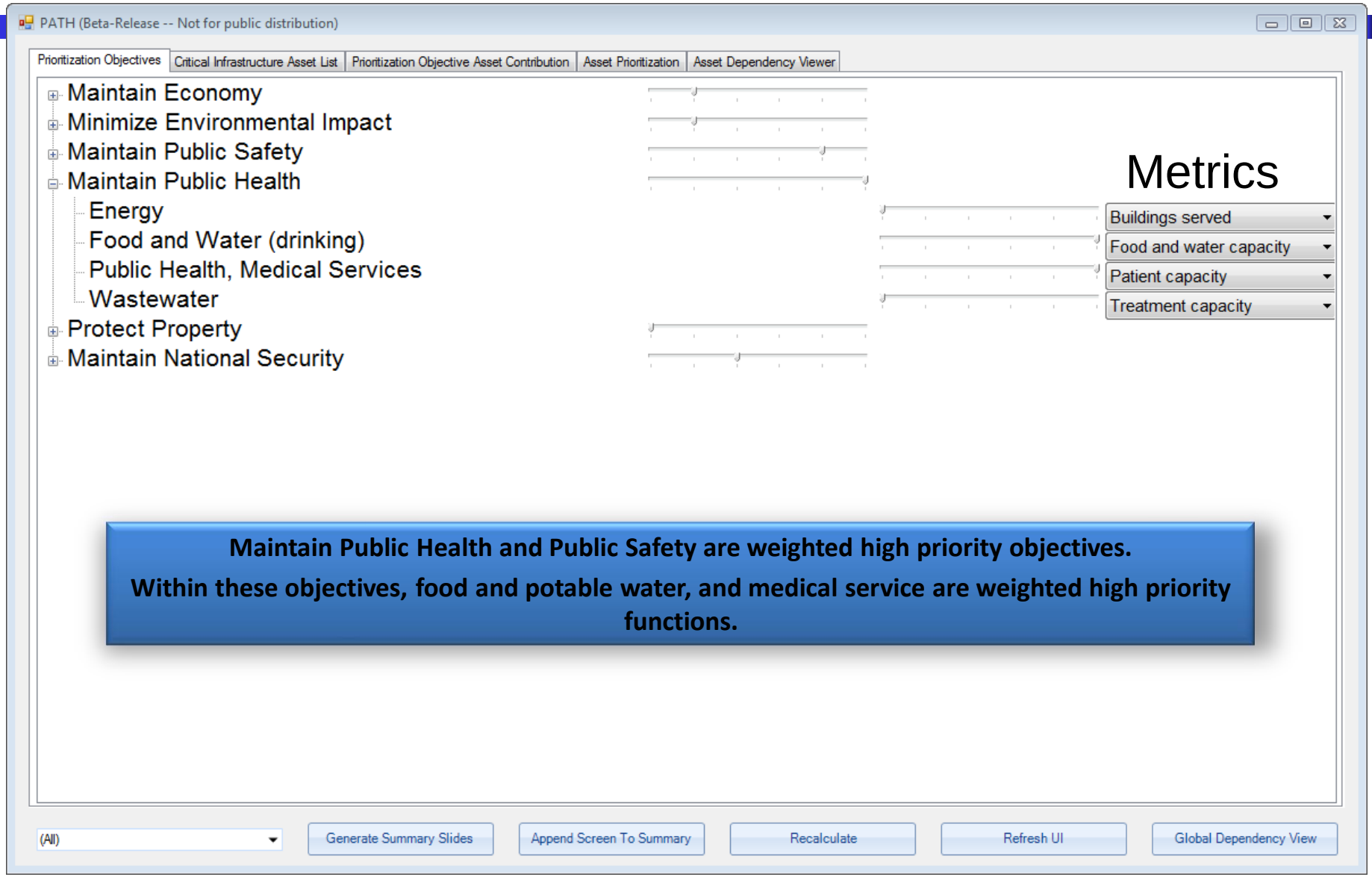
PATH User Input: Objective and Function Weightings



Maintain Public Health and Public Safety are weighted high priority objectives.

Within these objectives, food and potable water, and medical service are weighted high priority functions.

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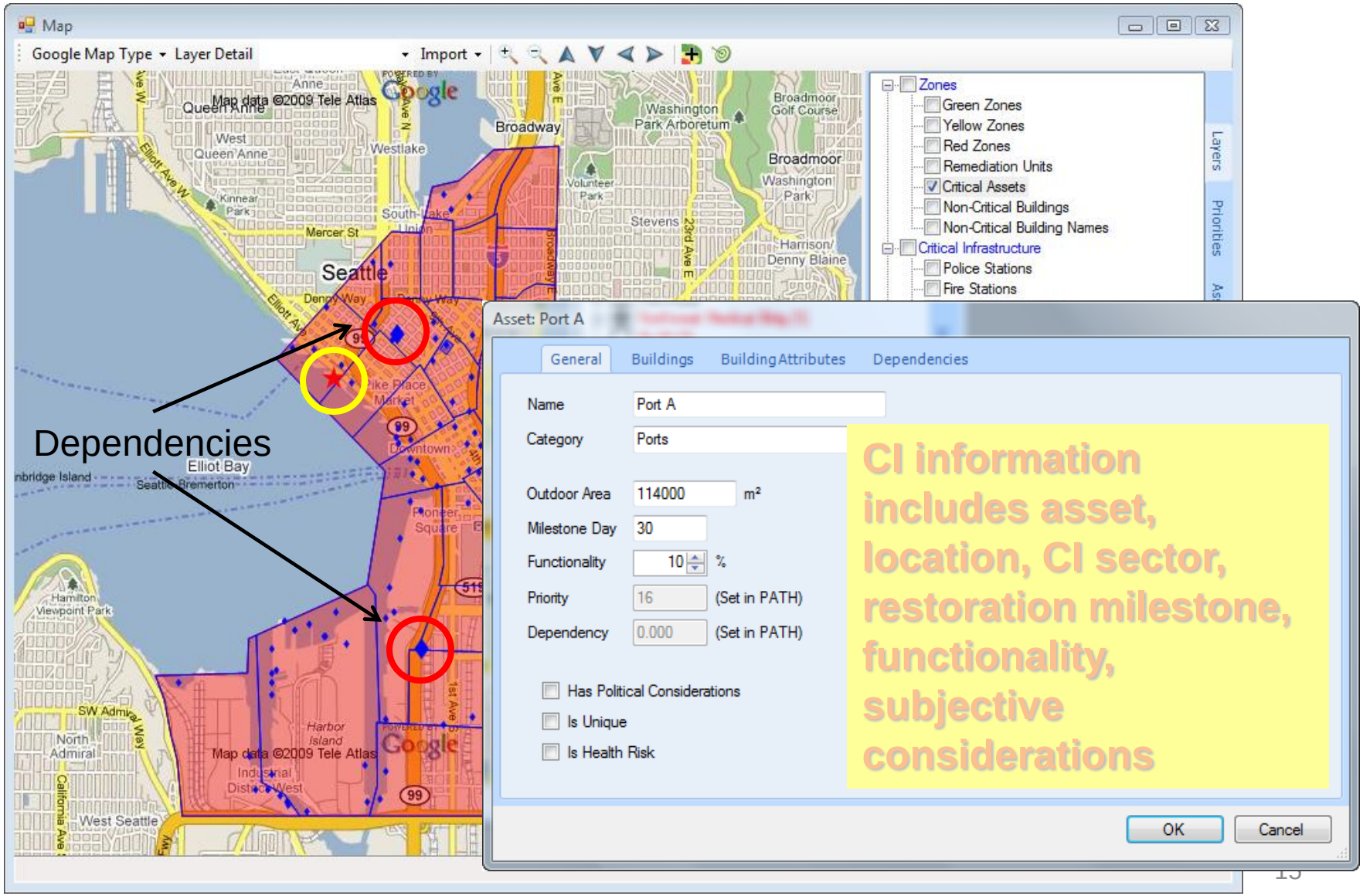
PATH User Input: Additional CI information



PATH Output: Prioritized List of Critical Infrastructure

PATH / AWARE - [PATH (Beta-Release -- Not for public distribution)]

File View Window Help

Prioritization Objectives | Critical Infrastructure Asset List | Prioritization Objective Asset Contribution | Asset Prioritization | Asset Dependency Viewer

Drag a column

Pri	Name	Category	SpecialI...	Overall...	Maintain Economy	Mini...	Maintain Public Safety	Maintain Public Health
1	Interstate B	[illegible]	EA	0.13	0.97	0.00	0.00	0.00
2	Blood Bank A	Hospital	EA	0.13	0.86	0.00	0.00	0.00
3	Hospital D	Hospital		0.13	0.00	0.00	0.00	0.99
4	Military asset	CellularTowers		0.14	0.96	0.00	0.97	0.00
5	Hospital B	Hospital		0.08	0.92	0.00	0.00	0.98
6	Fire Station 12 (EOC)	Fire		0.07	0.00	0.00	0.99	0.00
7	Police HQ	Police	EA	0.07	0.00	0.00	0.93	0.00
8	Police Station A	Police		0.07	0.00	0.00	0.98	0.00
9	Hospital C	Hospital		0.06	0.84	0.00	0.00	0.97
10	Port Railyards	Railyards	EA	0.04				
11	Port Terminal A	Ports		0.04				
12	Army Medical Center	Hospital		0.04				

A logical, transparent, prioritized asset list provides a good starting point for negotiation and decision making

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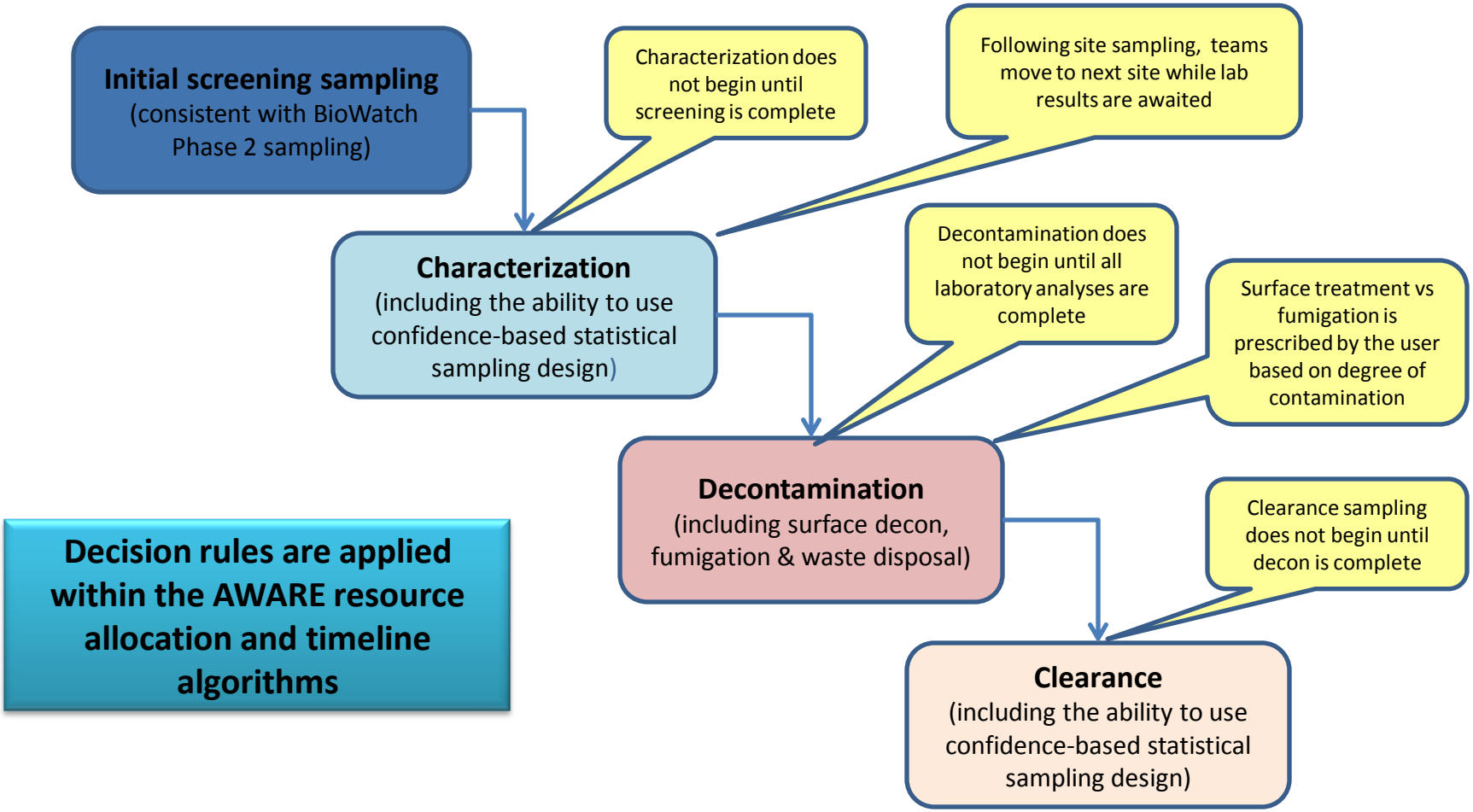
AWARE: Remediation Process Logic

AWARE addresses the Consequence Management phase of response and recovery, encompassing the following activities:



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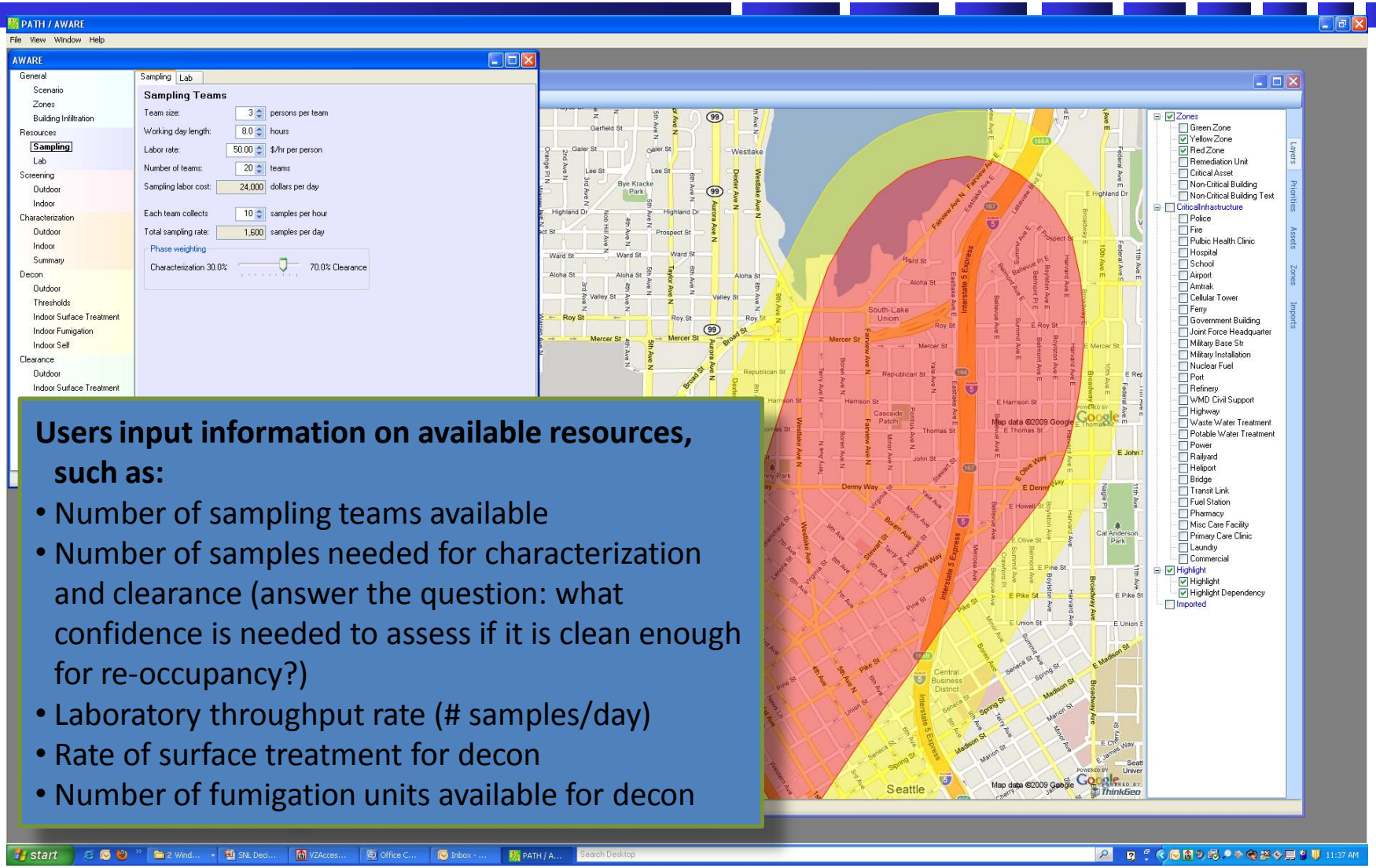
User Input: Sampling and Analysis Resources



Users input information on available resources, such as:

- Number of sampling teams available
- Number of samples needed for characterization and clearance (answer the question: what confidence is needed to assess if it is clean enough for re-occupancy?)
- Laboratory throughput rate (# samples/day)
- Rate of surface treatment for decon
- Number of fumigation units available for decon

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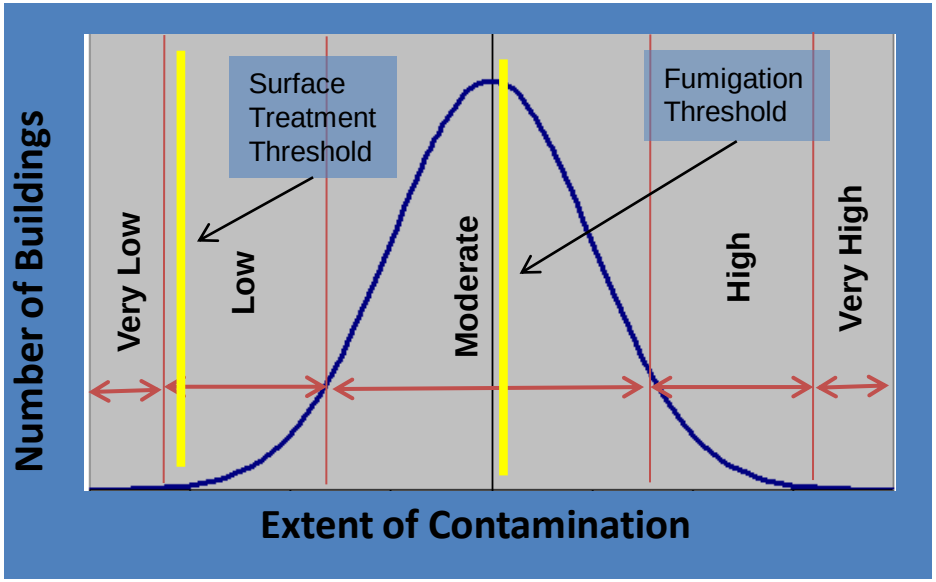
Decontamination Phase Assumptions

Key Decon Phase Assumptions

- Outdoor decon precedes indoor decon
- Extent of spore infiltration into buildings is normally distributed
- Buildings binned into small, medium and large categories
- Type of decon used correlates to degree of contamination
- User-defined thresholds for decon technology selection (e.g. surface treat vs. fumigation)



Predicting the degree of spore infiltration into buildings is highly uncertain. Additional research is needed in this area

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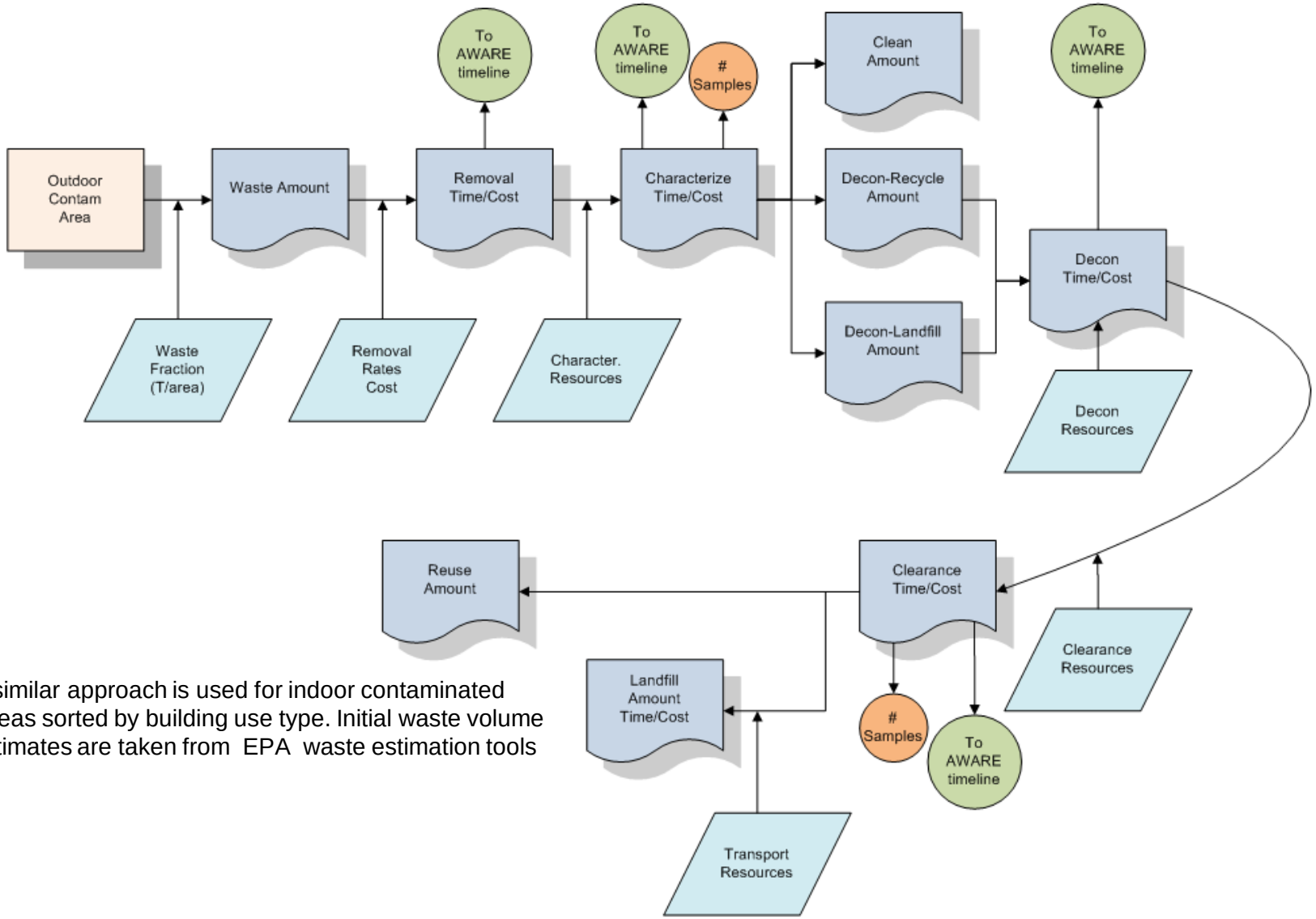
Waste Handling Logic and User Inputs



A similar approach is used for indoor contaminated areas sorted by building use type. Initial waste volume estimates are taken from EPA waste estimation tools

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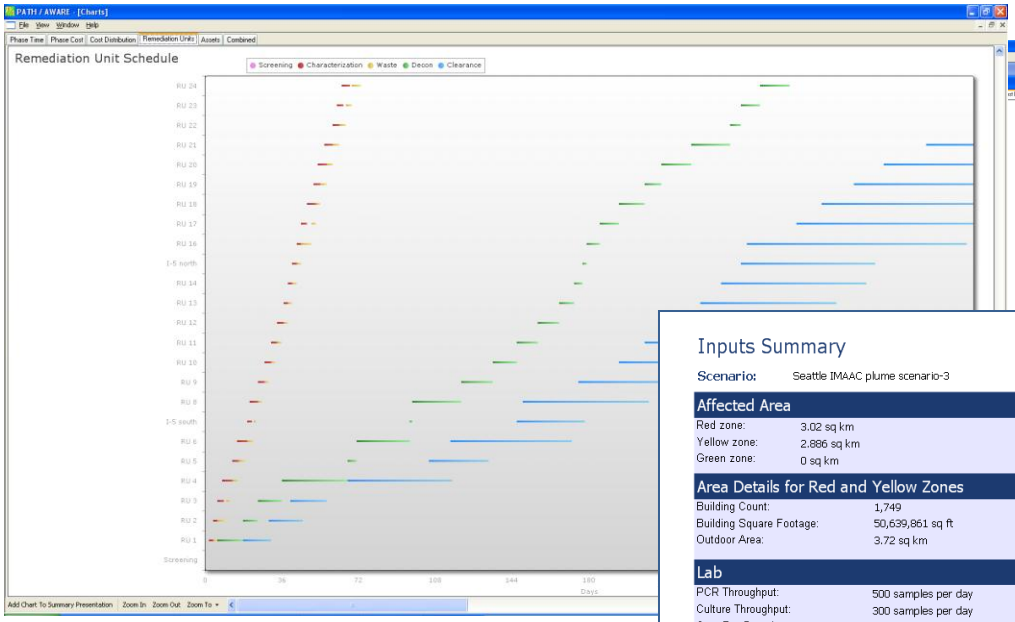
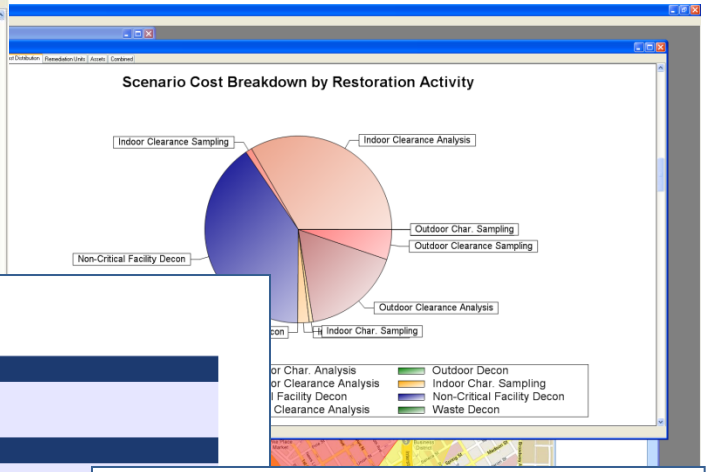
AWARE Output Formats





Inputs Summary

Scenario: Seattle IMAAC plume scenario-3

Affected Area

Red zone:	3.02 sq km
Yellow zone:	2.886 sq km
Green zone:	0 sq km

Area Details for Red and Yellow Zones

Building Count:	1,749
Building Square Footage:	50,639,861 sq ft
Outdoor Area:	3.72 sq km

Lab

PCR Throughput:	500 samples per day
Culture Throughput:	300 samples per day
Cost Per Sample	50 teams

Sampling

Team Size:	3 persons per team

Results Summary

Screening

Outdoor Red zone:	242 samples
Outdoor Yellow zone:	130 samples
Outdoor Green zone:	0 samples
Outdoor total:	372 samples
Indoor Red zone:	2,970 samples
Indoor Yellow zone:	2,277 samples
Indoor Green zone:	0 samples
Indoor total:	5,247 samples

Characterization

Judgmental

Outdoor Red zone:	484 samples
Outdoor Yellow zone:	261 samples
Outdoor total:	745 samples

Indoor Red and Yellow:

	Samples	Duration	Labor	Analysis Duration	Analysis Labor
Residential:	22,146	31 days	$1,107,300	28 days	$1,107,300
Commercial:	18,450	26 days	$922,500	24 days	$922,500
Mixed:	2,329	4 days	$116,400	3 days	$116,450
Industrial:	4,384	7 days	$219,150	6 days	$219,200
Public:	3,330	5 days	$166,500	5 days	$166,500
Total:	50,639	73 days	$2,531,850	66 days	$2,531,950

Outputs from AWARE include:

- Timelines by restoration phase
- Cost estimates
- Summary reports that document the scenario and restoration activity estimates

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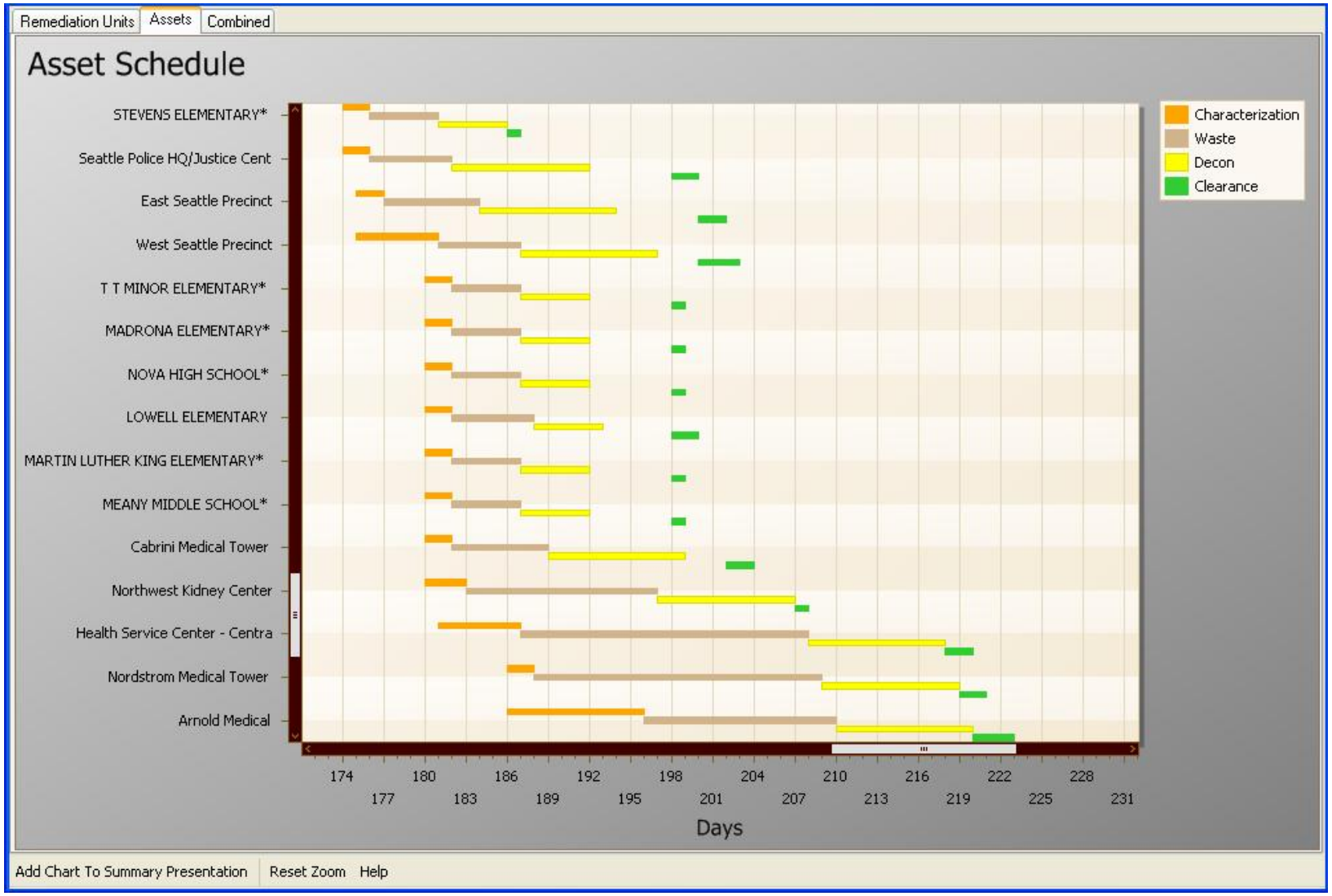
PATH/AWARE Output: Remediation Timeline for Prioritized Assets



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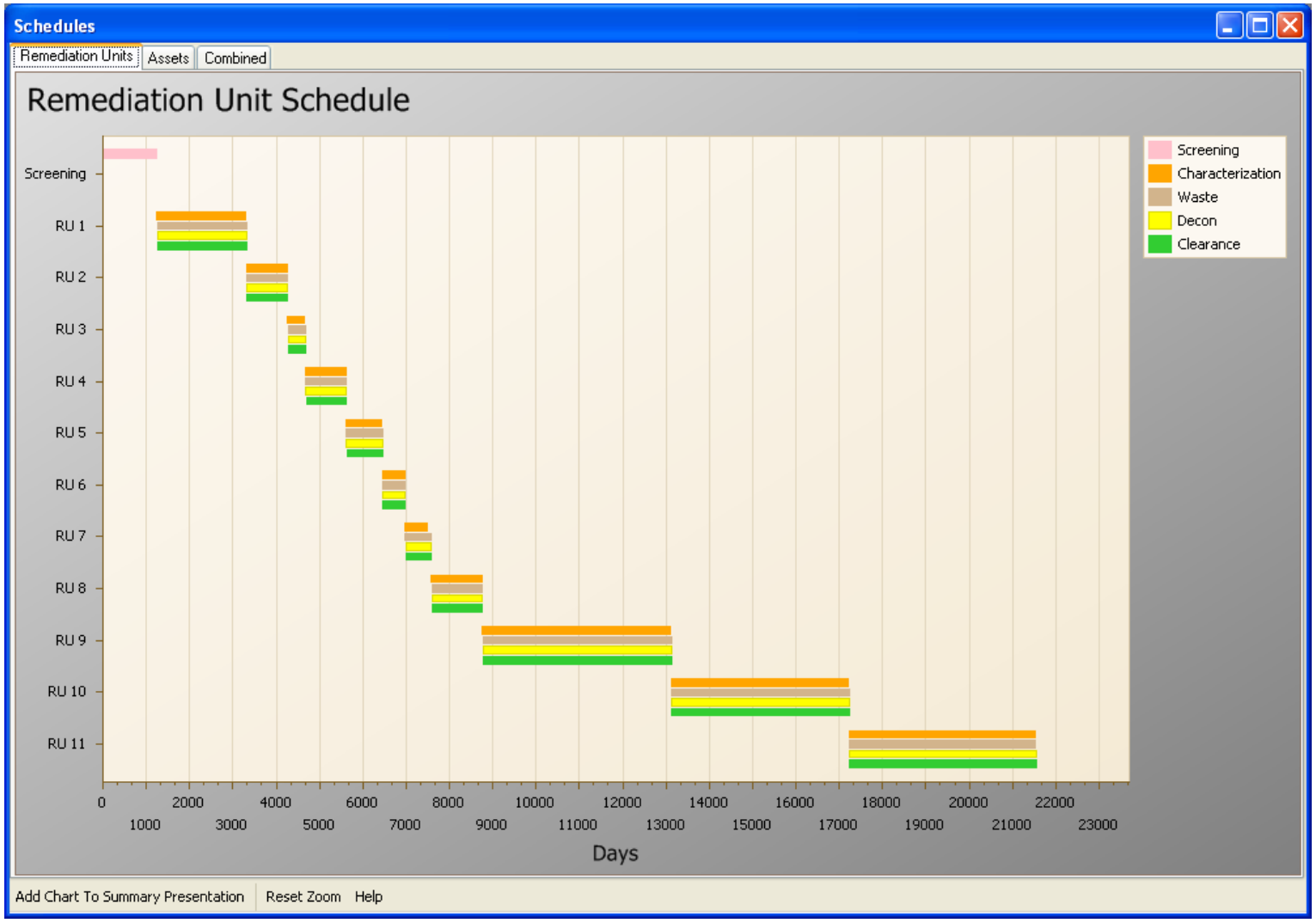
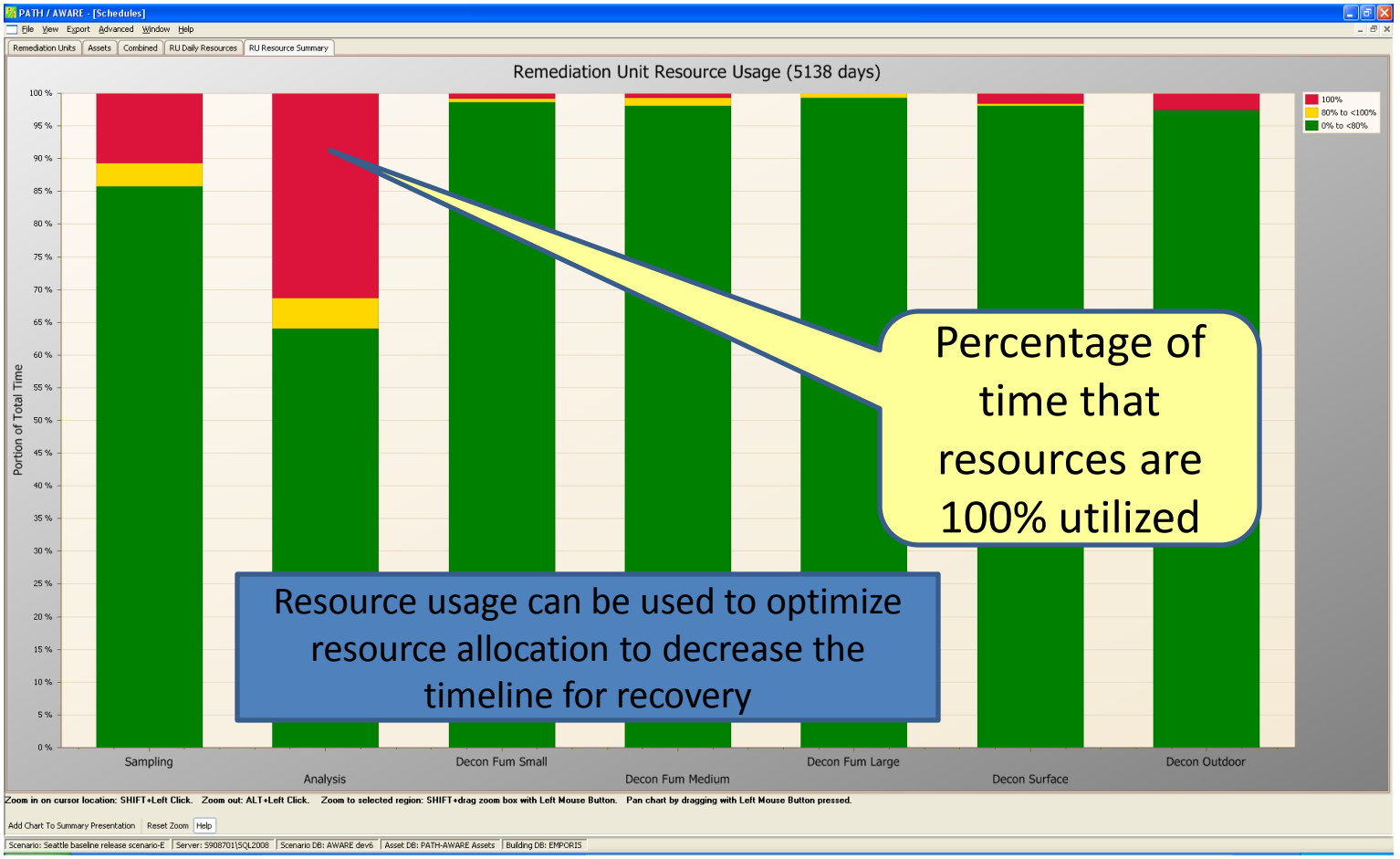
AWARE Output:
Remediation Timeline for All Buildings/Areas



Resource Utilization



Chemical Restoration Operational Technology Demonstration (OTD) Project Workshop

PATH/AWARE Software Technical Specifications

- PC platform with .Net Framework
- C++ programming language
- Uses MS SQL Server (no user fees)
- Stand-alone or server database versions
- ThinkGeo® Mapping Utility (no user fees)
- Access to Local City/County Tax Assessor Databases (requires data formatting for each locale)
- Access to DHS-developed HSIP Critical Asset Database
- Access to FEMA-developed HAZUS Building Database (implementation in progress)
- Web-served application (in the planning stages)

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PATH/AWARE Summary

- Response and recovery following a National Planning Scenario 2 incident will be ***costly and time consuming***
- The PATH/AWARE decision support tool provides insight to decision makers, for ***pre-planning and post-incident consequence management*** activities
- These tools provide a means of ***estimating and balancing resource requirements*** (e.g., number of fumigation units needed, laboratory throughput capacity, etc.) and may provide the basis for a more efficient response and recovery effort
- Analyses with tools like PATH/AWARE may lead to ***policy changes***
- These tools would be beneficial to decision makers in multiple jurisdictions and agencies/departments; however, a well-planned ***transition strategy*** is essential


Bio release detected or suspected
IMAAC, HPAC, BioWatch, Early Screening…, for initial estimates of contaminated area
GIS Engine collects & organizes all relevant facility/area
PATH prioritizes facilities and areas for remediation
BROOM is used for data collection, management and analysis during all phases of remediation
AWARE and RESTORe define and allocate remediation resources, tactics; time and cost estimates
Decon Technology Selection Tool guides decon strategy/tactics
ADVISER is an overarching response and restoration decision framework
RESTORe
Overview

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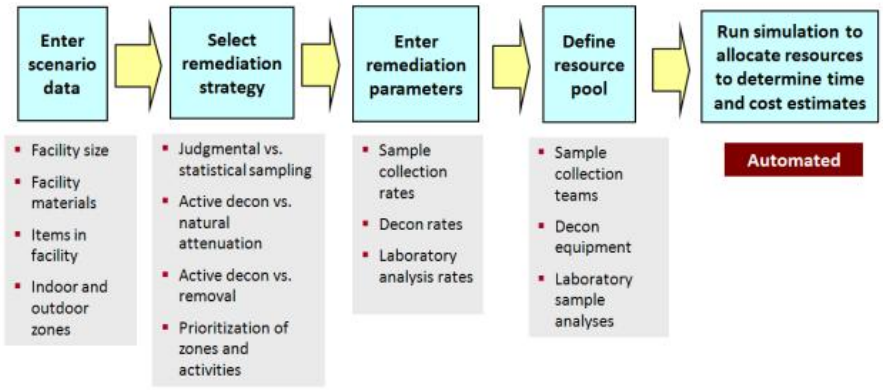
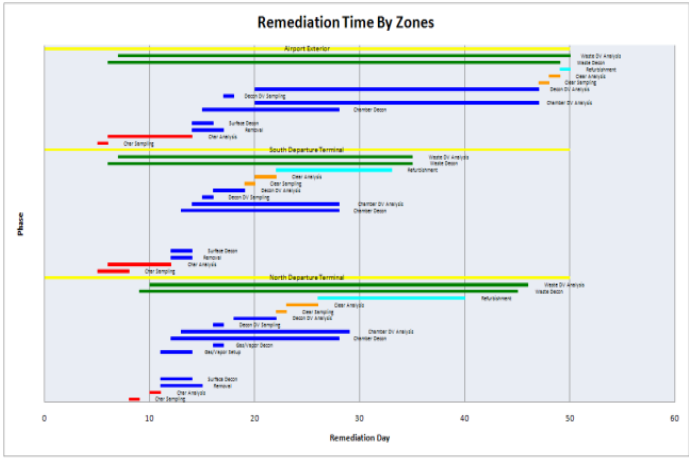
RESTORe: Resource Estimation and Scheduling Tool for Optimized Recovery

- Detailed resource estimation and scheduling tool for remediation
- Calculates time and cost of recovery
- Estimates required resources
- Quickly evaluates remediation strategies
- Determines choke-points in process
- Allows "what if" assessments



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



Technology, capability, and resource trade-off analyses can yield important information for resource allocation and prioritization.

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Steps to run a RESTORe simulation and analysis

Enter scenario data

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

Select remediation strategy

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

Enter remediation parameters

- Sample collection rates
- Decontamination rates
- Laboratory analysis rates

Define resource pool

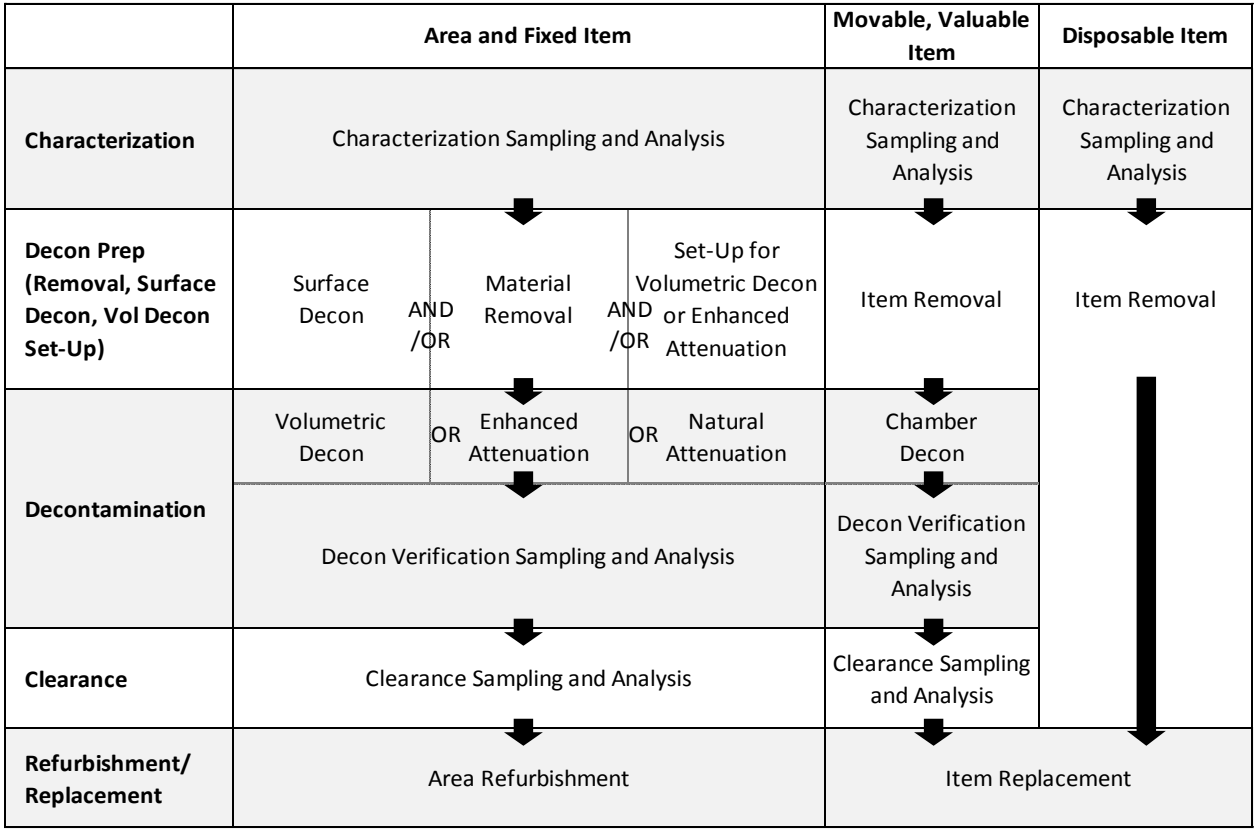
- Sample collection teams
- Decon equipment
- Laboratory sample analyses

Run simulation to allocate resources to determine time and cost estimates

Automated

Vary resources and resource allocation to evaluate remediation strategies and to optimize the recovery process

Remediation logic implemented in RESTORe



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

Resources are assigned to activities based on the user-defined remediation strategy

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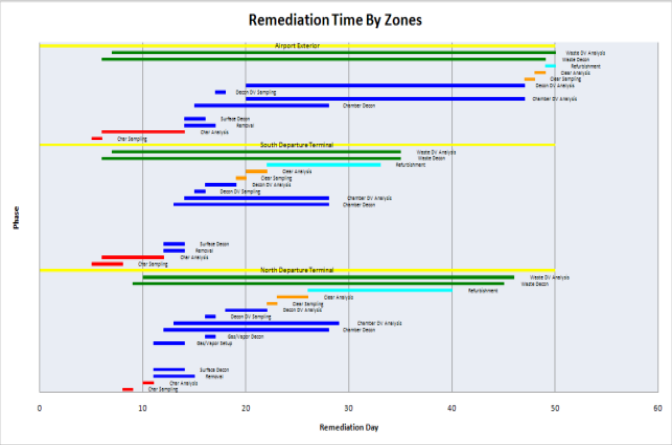
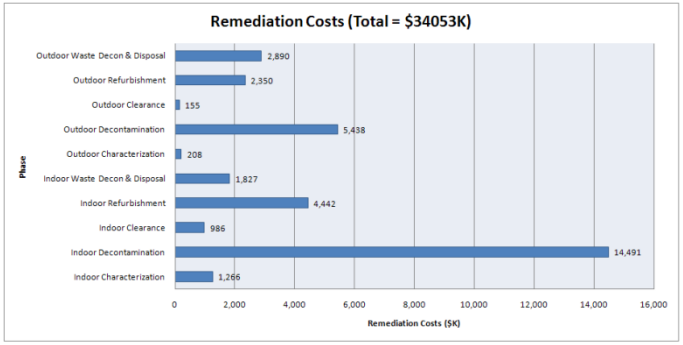
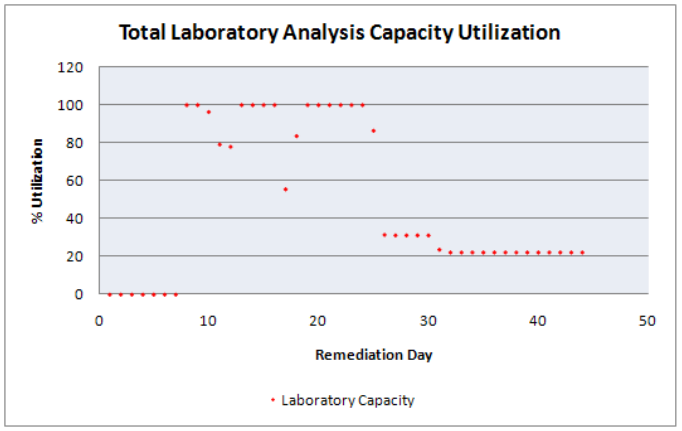
Results of a RESTORe Remediation Simulation



Remediation Timeline Plot



Cost Summary Plot



Resource Utilization Plots

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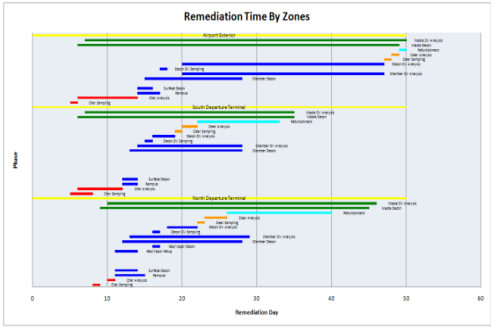
Summary Tables

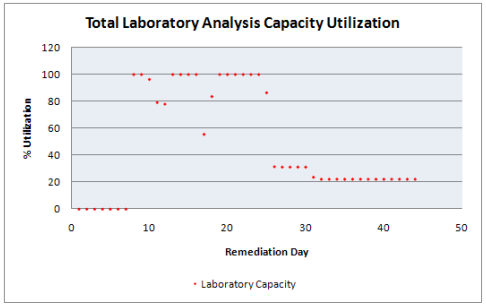
Chemical Restoration Operational Technology Demonstration (OTD) Project Workshop

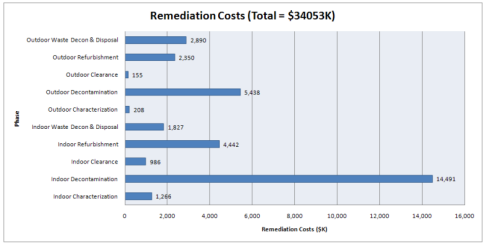
RESTORe Summary

- RESTORe enables detailed analyses of facility remediation
  - Time and cost
  - Resource utilization
  - Analyses of alternative strategies
- RESTORe was developed as part of the Chemical Restoration OTD project
  - Funded by DHS S&T
  - Focused on remediation following the release of a chemical warfare agent or toxic industrial chemical
- RESTORe logic is being 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 JAVA-coded version

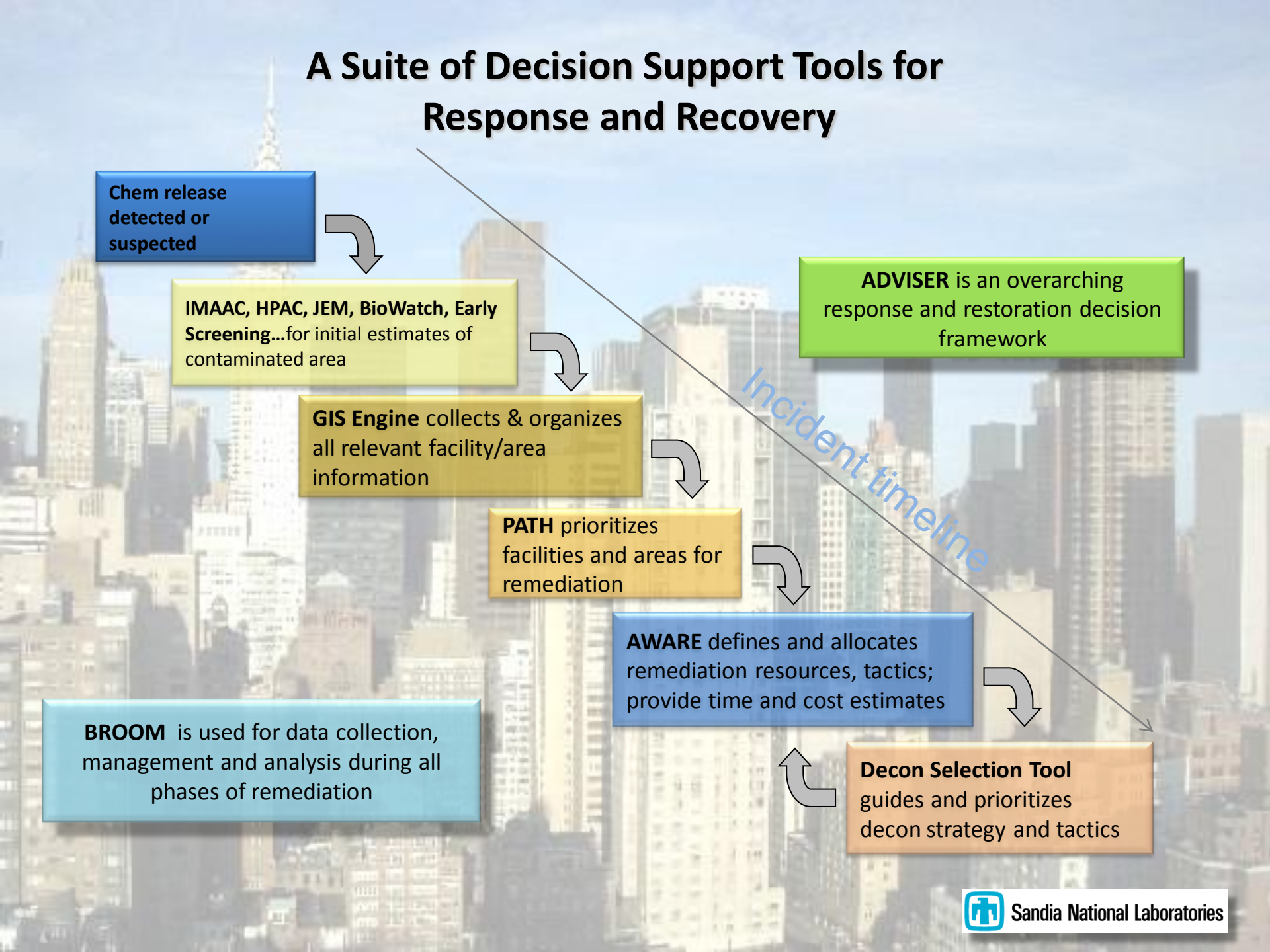
RESTORe_xl
Resource Estimation and Scheduling Tool for Optimized Recovery







A Suite of Decision Support Tools for Response and Recovery



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