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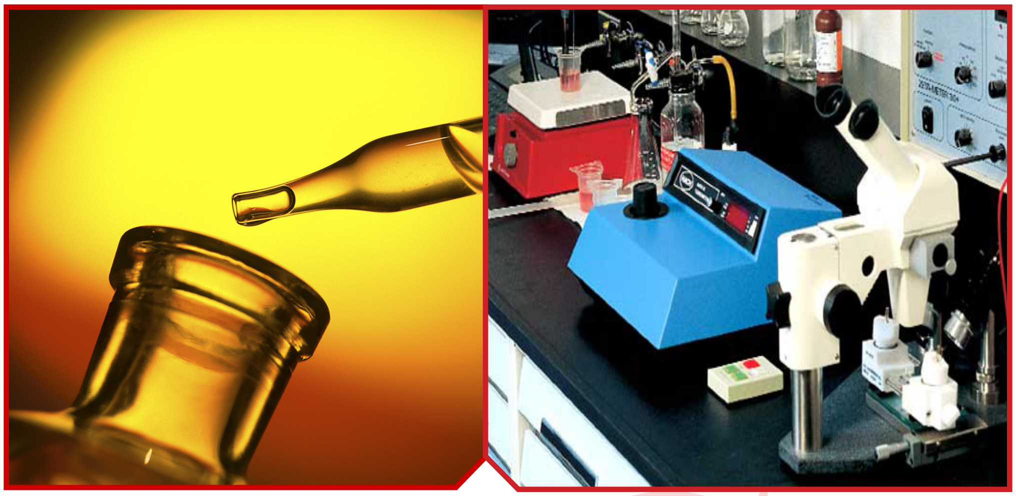
Rapid Screening and Preliminary Identification Techniques and Methods

Companion to Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM) - Revision 5.0



Office of Research and Development
National Homeland Security Research Center

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Companion to Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM) – Revision 5.0

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Acknowledgements

This document was developed by the U.S. Environmental Protection Agency's (EPA) National Homeland Security Research Center (NHSRC) within EPA's Office of Research and Development as a companion to NHSRC's *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events* (SAM), Revision 5.0. We wish to acknowledge the external peer reviews conducted by Zia Bukhari of American Water, Larry Burchfield of the Radiochemistry Society, Gary T. Hunt of TRC Environmental, Fred Lee of G. Fred Lee & Associates, and Jordan Peccia of Yale University whose thoughtful comments contributed greatly to the quality of the information. The document was prepared by Computer Sciences Corporation (CSC) under EPA Contract No. EP-W-06-046.

Disclaimer

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Foreword

Following the events of September 11, 2001, EPA's mission was expanded to account for critical needs related to homeland security. Presidential Directives identified EPA as the primary federal agency responsible for the country's water supplies and for decontamination following a chemical, biological, and/or radiological (CBR) attack. To provide scientific and technical support to help EPA meet this expanded role, EPA's National Homeland Security Research Center (NHSRC) was established. The NHSRC research program is focused on conducting research and delivering products that improve the capability of the Agency to carry out its homeland security responsibilities.

One specific focus area of NHSRC's research is to support the Environmental Response Laboratory Network (ERLN), a nationwide association of federal, state, local, and commercial environmental laboratories, established by EPA. The ERLN can be deployed in response to a large-scale environmental disaster by providing consistent analytical capabilities, capacities, and quality data in a systematic, coordinated manner. Toward this end, NHSRC has worked with experts from across EPA and other federal agencies to develop a compendium of analytical methods to be used in support of remediation following national homeland security related incidents. For specific analytes that have been determined to be of concern during a homeland security related event, analytical methods have been chosen to measure levels of contamination in different environmental matrices. The results of these efforts have been published in EPA's *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events* (SAM), available at http://www.epa.gov/sam.

In identifying and selecting appropriate analytical methods to be used in such instances, EPA recognized that there may be situations in which laboratories receive large numbers of samples or when rapid analyses are needed to support decision making. This document partially addresses these situations by **providing summary information regarding techniques, instruments, and/or methods that can be used for rapid laboratory screening of samples and preliminary identification of the chemical and radiochemical analytes listed in SAM.**

NHSRC has made this publication available to assist in preparing for and recovering from disasters involving chemical, radiochemical, and biological contamination; it specifically represents an important next step in supporting the ERLN. We value your comments as we move toward the development of an efficient process to manage environmental samples and move EPA one step closer to achieving its homeland security mission and its overall mission of protecting human health and the environment while supporting sustainable solutions.

Gregory D. Sayles, Ph.D., Acting Director
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Acronyms and Abbreviations

AA	Atomic Absorption
AES	Atomic Emission Spectrometry or Spectrograph
AMD	Automated Multiple Development
ASTM	American Society for Testing and Materials
APCI	Atmospheric Pressure Chemical Ionization
ºC	Degrees Centigrade
$CaCO_3$	Calcium carbonate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSC	Computer Sciences Corporation
CVA	Coefficient of variation
2-CVAA	2-Chlorovinylarsonous acid
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane)
DESI	Desorption Electrospray Ionization
DIMP	Diisopropyl methylphosphonate
DMT	3,4-Dimercaptotoluene
DMT	N,N-Dimethyltryptamine
DNT	Dinitrotoluene
2,6-DNT	2,6-Dinitrotoluene
DSCM	Dry standard cubic meter
EA2192	Diisopropylaminoethyl methylthiophosphonate
ECD	Electron Capture Detector
ED	Ethyldichloroarsine
EDEA	N-Ethyldiethanolamine
EDT	1,2-Ethane dithiol
EI	Electron ionization
ELISA	Enzyme Linked Immunosorbent Assay
EMPA	Ethyl methylphosphonic acid
EMSL	Environmental Monitoring and Support Laboratory
EPA	U.S. Environmental Protection Agency
ESI	Electrospray Ionization
FID	Flame Ionization Detector
FL	Fluorescence
FPD	Flame Photometric Detector
FRMAC	Federal Radiological Monitoring and Assessment Center
FTIR	Fourier Transform Infrared
g	Gram(s)
GA	Tabun
GB	Sarin
GC	Gas Chromatograph or Gas Chromatography
GD	Soman
GE	1-Methylethyl ester ethylphosphonofluoridic acid
GF	Cyclohexyl sarin
GFAAS	Graphite Furnace Atomic Absorption Spectrophotometer or Spectrophotometry
HASL	Health and Safety Laboratory (currently Environmental Measurements Laboratory)
HD	Mustard, sulfur/mustard gas
HMTD	Hexamethylenetriperoxidediamine
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HN-1	Nitrogen mustard 1; bis(2-chloroethyl)ethylamine

HN-2	Nitrogen mustard 2; N,N-bis(2-chloroethyl)methylamine
HN-3	Nitrogen mustard 3; tris(2-chloroethyl)amine
HPLC	High Performance Liquid Chromatograph or Chromatography
HPTLC	High Performance Thin-layer Chromatography
HRP	Horseradish peroxidase
IC	Ion Chromatograph or Chromatography
ICP	Inductively Coupled Plasma
IMPA	Isopropyl methylphosphonic acid
ISE	Ion Specific Electrode
JCAD	Joint Chemical Agent Detector
kg	Kilogram(s)
L	Liter
L-1	Lewisite 1; 2-Chlorovinyldichloroarsine
L-2	Lewisite 2; bis(2-Chlorovinyl)chloroarsine
L-3	Lewisite 3; tris(2-Chlorovinyl)arsine
LC	Liquid Chromatograph or Chromatography
LLE	Liquid-Liquid Extraction
M	Molar (concentration)
m^3	Cubic meter(s)
MCPA	2-methyl-4-chlorophenoxyacetic acid; (4-chloro-2-methylphenoxy) acetic acid
MDL	Method detection limit
MEKC	Micellar electrokinetic capillary chromatorgraphy
MeOH	Methanol
mg	Milligram(s)
mL	Milliliter(s)
mm	Millimeter(s)
MPA	Methylphosphonic acid
MS	Mass Spectrometer or Spectrometry
MSD	Mass Selective Detector
n	Number
N	Normal
NG	Nitroglycerine
ng	Nanogram(s)
NHSRC	National Homeland Security Research Center
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
nm	Nanometer(s)
NPD	Nitrogen-phosphorus Detector
NOS	Not Otherwise Specified
NTP	National Toxicology Program
OAQPS	Office of Air Quality Planning and Standards
ORD	Officer of Research and Development
ORIA	Office of Radiation and Indoor Air
ORISE	Oak Ridge Institute for Science and Education
OSHA	Occupational Safety and Health Administration
OVS	OSHA Versatile Sampler (tube)
OW	Office of Water
PAO	Phenylarsine oxide
pCi	Picocurie(s)
PDECD	Pulsed Discharge Electron Capture Detector
PDMS	Polydimethyl siloxane
PERALS®	Photon-electron Rejecting Alpha Liquid Scintillation
PETN	Pentaerythritol tetranitrate

pg.	Page(s)
PID	Photo-ionization Detector
PMPA	Pinacolyl methyl phosphonic acid
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per trillion
PV	Partially validated
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
Rh-102m	Metastable rhodium-102
RSD	Relative Standard Deviation
SAM	*Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events*
SDWA	Safe Drinking Water Act
SIM	Selective Ion Monitoring
SM	Standard Method
SPADNS	4,5-Dihydroxy-3-(p-sulfophenyazo)-2,7-hapthalene-disulfonic acid trisodium salt
SPE	Solid-Phase Extraction
SPME	Solid-Phase Microextraction
SRM	Standard Reference Matrix
SW	Solid Waste
S:N	Signal-to-noise ratio
TATP	Triacetone triperoxide
Tc-99m	Metastable technetium-99
TDE	Tetrachlorodiphenylethane
TDG	Thiodiglycol
TEA	Triethanolamine
TLC	Thin-Layer Chromatography
1,3,5-TNB	1,3,5-Trinitrobenzene
TNT	Trinitrotoluene
2,4,6-TNT	2,4,6-Trinitrotoluene
TO	Toxic Organics
UV	Ultraviolet
VE	Phosphonothioic acid, ethyl-, S-(2-(diethylamino)ethyl) O-ethyl ester
VM	Phosphonothioic acid, S-(2-(diethylamino)ethyl) O,O-diethyl ester
VR (R-33)	Methylphosphonothioic acid, S-[2-(diethylamino)ethyl] O-2-methylpropyl ester
V/V	Volume/Volume
VX	O-Ethyl-S-(2-diisopropylaminoethyl)methylphosphonothiolate
Xe-131m	Metastable xenon-131

Rapid Screening and Preliminary Identification Techniques and Methods

[Companion to Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM)]

1.0 Background

The U.S. Environmental Protection Agency's (EPA's) National Homeland Security Research Center (NHSRC) has worked with experts from across EPA and its sister agencies since 2003 to develop a compendium of analytical methods to be used when multiple laboratories are needed to analyze samples during environmental restoration following national homeland security related incidents. Analytical methods have been selected for measurement of chemical, radiochemical, pathogen, and biotoxin analytes of concern for the types of environmental sample matrices that are anticipated to be impacted by such incidents. The results of these efforts have been published in several revisions of EPA's *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events* (SAM), available at http://www.epa.gov/sam. NHSRC periodically reviews and updates the SAM document to reflect improvements in analytical methods and new technologies, and to incorporate changes in target analytes.

During development of SAM, EPA recognized that there may be situations in which laboratories receive large numbers of samples or when rapid analyses are needed to support decision making. This document is intended to partially address these situations by providing summary information regarding techniques, instruments, and/or methods that can be used for rapid laboratory screening of samples and preliminary identification of the chemical and radiochemical analytes listed in SAM, Revision 5.0.* As with SAM, NHSRC plans to update the information in this document periodically to reflect changes to the analytes and/or methods.

The information contained in this document is intended to support NHSRC's effort to provide procedures for use when multiple laboratories are needed to perform rapid preliminary analysis of environmental samples following a homeland security event. The information will be reviewed and updated periodically, along with the SAM document, to reflect advances in technologies, results of equipment testing and method evaluation, and additional analytes or sample matrices.

2.0 Scope and Application

The information in this document is intended to assist the parties responsible for preparing laboratories and/or response programs for scenarios in which rapid screening of environmental samples is required. This document provides general information for use by EPA and its contractors when rapid preliminary analysis of samples is needed to support and expedite decision making. Information included in this document should be used to support decisions regarding sample disposition, sample prioritization, and selection of confirmatory analytical methods (i.e., what method/instrumentation should be used for analyte confirmation and measurement). It is assumed that personnel using the information are knowledgeable about the

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* SAM, Revision 5.0 and its methods are available at: www.epa.gov/sam/pdfs/reportSAM092909.pdf.

contaminants of concern and experienced in applying the equipment and procedures for preparation and analysis of environmental samples.

2.1 Preliminary Identification Analysis

Unlike SAM, which identifies a single method for confirmatory analysis and measurement of each analyte in each sample type pair, this companion document lists multiple options that are considered appropriate for providing preliminary presence/absence determinations and identification of SAM chemical and radiochemical analytes. It is assumed that, at this stage in sample analysis, the type of contamination is known (e.g., radiochemical, chemical, organic versus inorganic, chemical agents) and rapid decisions are needed to avoid use of inappropriate or time-consuming confirmatory analyses. Summary information is provided regarding equipment and procedures that can be used for each chemical and radiochemical analyte in each environmental sample matrix listed in SAM, Revision 5.0, along with sources for additional information and summary comments regarding equipment considerations.

2.2 Information Tables

This document contains the following two tables which provide information regarding techniques, equipment, equipment capabilities (where available), and additional sources of information:

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM
Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM

Types of information provided in the tables include:

- **Analyte** – The compound or class of compounds that will be targeted by the screening procedure. The analytes in this document are identical to those listed in SAM.
- **Matrix** – The principal material of which the sample is composed. The matrices in this document are identical to the sample types listed for each analyte in SAM, Revision 5.0.
- **Reference Source** – The reference(s) supporting the information that is provided in the table.
- **Technique** – The equipment, instrumentation, and/or method that can be used for preliminary identification of an analyte or class of analytes in the environmental sample type (matrix).

2.3 Limitations

This document provides only summary information regarding techniques that can be used for rapid screening of samples for preliminary identification of the chemical and radiochemical analytes listed in SAM. Pathogen and biotoxin analytes are not addressed in the document at this time.

General information regarding currently available equipment and protocols is included; details regarding equipment use or analytical procedures, laboratory or field requirements, or analytical concerns are not provided. The document is intended for use in assisting responsible parties in preparing for scenarios in which rapid screening of environmental samples is required. It does not provide detailed procedures, laboratory or field requirements, and does not address analytical concerns. Document users should consult the sources cited in Section 3.0 (References) and in Tables 1 and 2 for additional details regarding testing and use of the equipment or methods listed. If confirmatory identification or quantification of the analytes is needed, laboratories should consult with the SAM document to identify appropriate analytical methods.

Although at this time, not all of the techniques and methods listed have been tested for a particular analyte or matrix, the information listed is considered to be the most appropriate information available at the time of publication. The SAM workgroup plans to review and update SAM and the SAM companion documents periodically to reflect advances in technologies, results of procedure evaluation and validation studies, and additional analytes or matrices.

3.0 References

Analytical methods listed in Tables 1 and 2 can be accessed through SAM at: www.epa.gov/sam. In addition to these methods, the following resources were used to prepare this document:

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Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM

Note: When available, information is provided regarding detection, quantitation, working range, performance, sample throughput, sample preparation, and interferences (see Comments column).

Analyte	Matrix	Technique	Reference Source*	Comments
Acephate	Air Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-MS	Journal of Chromatography A. 2007. 1154(1): 3–25	Quantitation: 0.01 mg/kg (limit of quantification) Working Range: 0.01 – 1.0 mg/kg Performance: Mean recovery range 70 – 110 (±15%) Sample Throughput: Retention time 4.70 min
	Aqueous Liquid Drinking Water		Chromatographia. 2006. 63(5/6): 233–237	Detection: Detection limit 30 µg/L Performance: Recovery range 95.3 – 118.4 % Sample Throughput: Retention time 4.39 min
Acrylamide **Acrylonitrile**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC	EPA Method 8316 (SW-846)	Detection: Detection limit 10 µg/L (acrylamide) and 20 µg/L (acrylonitrile) Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Air		OSHA Method PV2004	Detection: Detection limit 0.7 µg/mL (0.006 mg/m^3 for a 1-mL desorption volume or 0.029 mg/m^3 for a 5-mL desorption volume based on a 120-L air volume) Working Range: 0.017 – 1.5 mg/m^3 (1-mL desorption volume) and 0.083 – 7.5 mg/m^3 (5-mL desorption volume) Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Aldicarb (Temik) **Aldicarb sulfone** **Aldicarb sulfoxide**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	Immunoassay	RaPID Assay® Aldicarb (built to order) (fieldable) http://www.sdix.com (accessed November 19, 2009)	Detection: Minimum detection level 0.25 ppb (as aldicarb) Quantitation: 1 – 100 ppb (as aldicarb) Sample Preparation: Oil samples and non-aqueous liquid samples require extraction into water
			EnviroGard™ Aldicarb Plate Kit (fieldable) http://www.sdix.com (accessed November 19, 2009)	Detection: Least detectable dose 0.4 µg/L (aldicarb); 0.5 µg/L (aldicarb sulfone); 25.0 µg/L (aldicarb sulfoxide) Sample Preparation: Soil samples and non-aqueous liquid samples require extraction into water Interferences: Particles in untreated ground and surface water can affect the minimum detectable level Other: Does not differentiate between the three major forms of aldicarb (aldicarb, aldicarb sulfone, and aldicarb sulfoxide)
		HPLC	Journal of Chromatography A. 1996. 726: 99–113	Detection: Detection range 0.5 – 1.0; limit of detection 0.1 µg/L Quantitation: 1 – 100 ppb (as aldicarb) Working Range: Calibration range 1 – 1000 ng Performance: Mean recovery 89 (±11)% Sample Throughput: Retention time 23.8 minutes Sample Preparation: Soil samples require extraction into water Other: Diode array with online sample enrichment
		HPLC-ESI-MS-SIM	Analytica Chimica Acta. 2004. 505: 209–215	Sample Preparation: SPE, soil samples, and non-aqueous liquid samples require extraction into water Other: Tested for similar compounds (carbofuran, methomyl, oxamyl, etc.)
		MEKC	Electrophoresis. 2001. 22(11): 2260–2269	Detection: Detection limit 0.46 µg/L Quantitation: Quantitation limit 1 µg/L Working Range: Working range 1 – 40 µg/L Performance: Recovery 48 (±26)% (drinking water) Sample Throughput: Retention time <2 minutes Sample Preparation: SPE and sample stacking. Soild samples require extraction into water. Water samples require adjustment to pH 2 – 3.
	Air	HPLC-UV	NIOSH Method 5601	Detection: Detection limit 0.005 µg/L Working Range: Working range 0.5 – 1 µg/L Sample Throughput: Retention times ~13.5 minutes (in MeCN); ~19.9 minutes (MeOH) Sample Preparation: Collect air samples on sorbents. Extraction (with 0.2% V/V 0.1 M aqueous triethylamine phosphate buffer in acetonitrile, pH 6.9 – 7.1) from filter/solid sorbent tube (OVS-2 Tube: 13-mm quartz fiber filter; XAD-2, 270 mg/140 mg) Interferences: Potential interferences include chloroform, toluene, BHT, dialkyl phthalates, nicotine, caffeine, impurities in HPLC reagents (e.g., in triethylamine), other pesticides (2,4-D, atrazine, parathion, etc.), and pesticide hydrolysis products (1-naphthol) Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Allyl Alcohol	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.
	Aqueous Liquid Drinking Water	GC-FID (direct injection)	EPA Method 8015C (SW-846)	Sample Preparation: Based on Method 8015C using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. A trip blank prepared from organic-free reagent water and carried through sampling and subsequent storage and handling must serve as a check on such contamination. Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Air	GC-FID (direct injection)	EPA Method TO-8 (ORD)	Other: Aqueous impinger collection
	Air	GC-MS	Modified EPA Method TO-10A or TO-17 (ORD)	Performance: For Method TO-10A, RSD ranges (depending on analyte) from 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
4-Aminopyridine	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC	EPA Method 8330B (SW-846)	Detection: ppb levels of certain explosives and propellant residues
		HPLC	Journal of Chromatography A. 1996. 726: 99–113	Sample Preparation: Soil and non-aqueous liquid/organic solid samples require extraction into water Other: Diode array with online sample enrichment. Tested for similar compounds.
		HPLC-ESI-MS-SIM	Analytica Chimica Acta. 2004. 505: 209–215	Sample Preparation: SPE. Soil and non-aqueous liquid/organic solid samples require extraction into water.
		MEKC	Electrophoresis. 2001. 22(11): 2260–2269	Sample Preparation: SPE and sample stacking. Soil samples require extraction into water. Tested for similar compounds.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Ammonia	Aqueous Liquid	Spectrophotometer (fieldable)	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 2.5 mg/L Interferences: Potential interferences include Cl, Mg, and Ca ions (>500 mg/L) Other: Nessler method
			Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.01 – 0.50 mg/L Interferences: Potential interferences include $CaCO_3$ >1000 mg/L; Fe (all levels); Mg >6000 mg/L; NO_3 >100 mg/L; NO_2 >12 mg/L; PO_4 >100 mg/L; SO_4 >300 mg/L Other: Salicylate method
	Drinking Water	Spectrophotometer (fieldable)	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.01 – 0.50 mg/L Interferences: Potential interferences include $CaCO_3$ >1000 mg/L; Fe (all levels); Mg >6000 mg/L; NO_3 >100 mg/L; NO_2 >12 mg/L; PO_4 >100 mg/L; SO_4 >300 mg/L Other: Salicylate method
			Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 2.5 mg/L Interferences: Potential interferences include Cl, Mg, and Ca ions (>500 mg/L) Other: Nessler method
		Potentiometric-ion selective electrode	EPA Method 350.3 (OW)	Detection: Detection range 0.01 – 0.50 mg/L Other: Color and turbidity have no interferent effect
	Air	Toxic Gas Leak detector (fieldable)	CEA A-5200 Toxic Gas Leak Detector http://www.ceainstr.com/pdf_datasheets/seriesu_Info.pdf (accessed November 19, 2009)	Detection: Detection ranges 0 – 100 ppm; 0 – 250 ppm; 0 – 500 ppm; 0 – 1000 ppm; 0 – 5000 ppm
		Draeger gas detection tube	Draeger gas detection tube Ammonia 0.25/a (P/N 8101711); 2/a (P/N 6733231); 5/b (P/N 8101941); 5/a (P/N CH20501) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection ranges 0.25 – 3 ppm; 2 – 30 ppm; 2.5 – 100 ppm; 5 – 700 ppm Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Ammonium metavanadate (analyze for total vanadium) **Arsenic, Total** **Arsenic trioxide (analyze for total arsenic)**	Air (particulates) Solid	X-ray fluorescence analyzer (fieldable)	EPA Method 6200 (SW-846)	Detection: Interference-free detection limit 40 mg/kg (arsenic) Quantitation: Semi-quantitative Interferences: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 0.20 mg/L (arsenic) Interferences: Potential interferences include antimony salts Other: Measures total arsenic. Silver diethyldithio-carbamate method.
	Non-aqueous Liquid/Organic Solid	ICP-MS	SW-846 Method 6020A (SW-846); EPA Method 200.8 (OW)	Detection: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES Sample Preparation: Extraction in aqueous nitric acid Other: Limited QC for rapid analysis
		ICP-AES	SW-846 Method 6010C (SW-846); EPA Method 200.7 (OW)	Detection: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES Sample Preparation: Extraction in aqueous nitric acid Other: Limited QC for rapid analysis
Arsine	Air Aqueous Liquid Drinking Water Solid Wipes	GC-PID, -FID, or -ECD	EPA field screening Method FM9	Detection: Used to screen water, air, soil, and sediment samples on a GC with a PID, FID, or ECD Sample Preparation: Method involves collecting desired sample in a 40-mL vial, preparing sample if soil or sediment, and sampling and analyzing vapor headspace above aqueous solution Other: Headspace analysis
		Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Used to screen water, air, soil, and sediment samples on a GC with a PID, FID, or ECD Sample Preparation: Method involves collecting desired sample in a 40-mL vial, preparing sample if soil or sediment, and sampling and analyzing vapor headspace above aqueous solution
	Air (particulates) Solid Wipes	Draeger-type gas detection tube or X-ray fluorescence analyzer (fieldable)	Draeger gas detection tube Arsine 140SA http://209.18.104.171/uploads/docLib_639_140SA.pdf (accessed November 19, 2009)	Detection: Detection limit 1 ppm (140SA); 0.05 – 60 ppm (0.05/a) Other: Draeger-type gas detection tube on headspace of sample container or by X-ray fluorescence
	Air (particulates) Solid Wipes	Draeger-type gas detection tube or X-ray fluorescence analyzer (fieldable)	Draeger gas detection tube Arsine 0.05/a (P/N CH25001) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection limit 1 ppm (140SA); 0.05 – 60 ppm (0.05/a) Other: Draeger-type gas detection tube on headspace of sample container or by X-ray fluorescence
	Solid Wipes	GFAAS, ICP, or GC-MSD	EPA Methods 6020A, 6010C, and 7010 (SW-846); EPA Methods 200.8 and 200.7 (OW)	Detection: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES Sample Preparation: HNO_3 extraction. Extract soil sample or desorb arsine from soil.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Asbestos	Solid	Polarized light microscopy	EPA Method 600/R-93/116 (ORD)	Detection: Operates at magnifications of 400X and will not resolve fibers below 0.25 µm in diameter. Cannot distinguish asbestos fibers from other fibers (e.g., gypsum, mineral wool, fiberglass, cellulose, etc.).
	Air		NIOSH Method 7400	
	Wipes	TEM	ASTM Method D6480-05	Other: Hard-surfaces wipes
Boron Trifluoride	Air	AA or ICP-AES	EPA Method 6010C (SW-846); EPA Method 200.7 (OW)	Detection: Estimated detection limit 3.8 µg/L
		Draeger gas detection tube; DraegerSensor® ACL (fieldable)	DraegerSensor® ACL (P/N 6809375) http://www.draeger.co.uk/ST/internet/pdf/Master/En/gt/9023564_pyl_ac_d_e.pdf (accessed November 19, 2009)	Detection: Detection range 1 – 14 ppm; DraegerSensor® 3 – 30 ppm
		ISE	OSHA Method ID216SG	Detection: Detection limit 0.4 µg/mL (10 µg/sample)
Brodifacoum **Bromadiolone** **BZ [Quinuclidinyl benzilate]**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-UV	Chemosphere. 2005. 61: 1580–1586	Detection: UV wavelength 310 nm Sample Preparation: Filtration, requires no extraction
		HPLC-APCI-MS-SPE	"A General Unknown Screening For Drugs and Toxic Compounds in Human Serum." Thesis. http://pages.unibas.ch/diss/2005/DissB_7295.pdf (accessed November 19, 2009)	Detection: Detection limit for bromadiolone in blood 1000 ng/mL (positive ion mode); 250 ng/mL (negative ion mode) Performance: Minimum recovery using SPE cartridge 31% (bromadiolone) Sample Throughput: Retention time ~12.86 minutes (bromadiolone) Sample Preparation: SPE cartridge extraction
		HPLC-APCI-MS-LLE	Journal of Chromatography B. 1999. 731: 155–165	Detection: Detection limit 1.0 ng/mL (blood); 0.5 ng/mL (urine) (bromadiolone) Sample Throughput: Retention time ~12.86 minutes (bromadiolone) Sample Preparation: Extraction with ethyl acetate and evaporation to dryness, followed by redissolving in acetonitrile
	Aqueous Liquid	Fluorescence with or without HPLC	Chemosphere. 2005. 61: 1580–1586	Detection: Detection limit for bromadiolone with the addition of cyclodexitrin 23 ng/mL (the addition of cyclodextrin resulted in an increase in fluorescence intensity at 390 nm of 13-fold)
	Air (BZ only)	HPLC	EPA Method TO-10A (ORD)	Other: Method listed in SAM for BZ and similar compounds (pesticides and polychlorinated biphenyls in air)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Calcium arsenate (analyze as total arsenic)	Air (particulates) Solid Wipes	X-ray fluorescence analyzer (fieldable)	EPA Method 6200 (SW-846)	Detection: Interference-free detection limit 40 mg/kg (arsenic) Quantitation: Semi-quantitative Interferences: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 0.20 mg/L (arsenic) Interferences: Potential interferences include antimony salts Other: Measures total arsenic. Silver diethyldithio-carbamate method.
	Non-aqueous Liquid/Organic Solid	ICP-MS	EPA Method 6020A (SW-846); EPA Method 200.8 (OW)	Detection: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES Sample Preparation: Extraction in aqueous nitric acid Other: Limited QC for rapid analysis
		ICP-AES	EPA Method 6010C (SW-846); EPA Method 200.7 (OW)	Detection: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES Sample Preparation: Extraction in aqueous nitric acid Other: Limited QC for rapid analysis
Carbofuran (Furadan)	Aqueous Liquid Drinking Water	Immunoassay	RaPID Assay® Carbofuran Test Kit http://www.sdix.com (accessed November 19, 2009)	Detection: Detection limit 0.056 ppb Quantitation: Quantitation range 0.1 – 5.0 ppb. Can be used as a quantitative, semi-quantitative, or qualitative enzyme immunoassay for analysis of carbofuran in water.
		HPLC	Journal of Chromatography A. 1996. 726: 99–113	Detection: Detection limit 0.05 µg/L Performance: Recovery 102% Sample Throughput: Retention time ~29 minutes Other: Diode array with online sample enrichment
		GC-MS	Journal of Chromatography A. 2002. 963: 107–116	Detection: Detection limit 0.05 µg/L Performance: RSD 11% Sample Throughput: Retention time ~27.4 minutes Sample Preparation: SPME
		LC-ESI-MS-SIM	Analytica Chimica Acta. 2004. 505: 209–215	Detection: Detection limit 0.10 µg/L Performance: Recovery 76.3% Sample Throughput: Retention time ~11 minutes Sample Preparation: SPE
		MEKC	Electrophoresis. 2001. 22(11): 2260–2269	Detection: Detection limit 0.17 µg/L Quantitation: Quantitation limit 0.4 µg/L Sample Throughput: Retention time ~2 minutes Sample Preparation: SPE and sample stacking

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Carbofuran (Furadan)	Non-aqueous Liquid/Organic Solid	HPLC-FL, -UV, or -MS	EPA Methods 8318A and 8321B (SW-846)	Working Range: 0.5 – 5.0 mg/L Sample Throughput: Retention time ~18.28 minutes Sample Preparation: Extraction with hexane, followed by extraction with acetonitrile Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Solid Wipes	GC-MS	Journal of Chromatography A. 2003. 994: 169–177	Detection: Detection limit 30.9 µg/kg Performance: Recovery 97.3% Sample Throughput: Extraction time 25 minutes; retention time 6.4 minutes Sample Preparation: Subcritical water extraction
	Air	HPLC-UV	NIOSH Method 5601	Detection: Detection limit 0.0025 µg/L Working Range: 0.05 – 1 µg/L Sample Preparation: Collect air samples on sorbents Other: Carbofuran has a very low vapor pressure (4.8×10^{-6} mm-Hg at 19°C); is not likely to be detected in air using portable instruments
Carfentanil	Aqueous Liquid	HPLC-UV	Chemosphere. 2005. 61: 1580–1586	Sample Preparation: Filtration, requires no extraction
	Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-APCI-MS-SPE	"A General Unknown Screening For Drugs and Toxic Compounds in Human Serum." Thesis. http://pages.unibas.ch/diss/2005/DissB_7295.pdf (accessed November 19, 2009)	Sample Preparation: SPE cartridge extraction
		HPLC-APCI-MS-LLE	Journal of Chromatography B. 1999. 731: 155–165	Sample Preparation: Extraction with ethyl acetate and evaporation to dryness, followed by redissolving in acetonitrile
		Immunoassay	Journal of Analytical Toxicology. 1990. 14(3): 160–164	Detection: 0.25 ng/mL
	Aqueous Liquid	Fluorescence with or without HPLC	Chemosphere. 2005. 61: 1580–1586	Other: Tested for similar compounds (bromadiolone)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Carbon disulfide	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.
	Air	GC-ECD, -FPD, or PID-MSD	American Industrial Hygiene Association Journal. 1978. 39(12): 939–944	Detection: Detection range 1.5 – 10 µg/m^3 Quantitation: 3 ppm for a 5-L air sample Working Range: 3 – 64 ppm for a 5-L air sample Sample Preparation: Concentrate on charcoal tubes, extract with acetonitrile
		GC-FPD	No Method Identified	Sample Preparation: Charcoal tube collection followed by solvent extraction
		GC-FID or -ECD	EPA Method TO-15	Other: Modified to use Tedlar® bags. Limited QC to ensure rapid analysis.
Chlorfenvinphos	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water) or 5035A (solid) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples and Method 5035A for solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Chlorfenvinphos	Air	Automated thermal desorption GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Samples can be analyzed only once Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)
Chlorine	Aqueous Liquid Drinking Water	Amperometric forward titration (fieldable), ion selective electrode, or colorimetric screening (fieldable)	Hach Water Analysis Handbook. 5th Edition. 2008 or EPA Method 9212	Detection: Detection range 0 – 1000 µg/L as Cl_2; detection range 0.4 – 1000 mg/L (Method 9212); detection limit 2.0 mg/L (Method 9212) Interferences: Potential interferences include Ag+, Cu+, Cu++; oxidized manganese; oxidizing agents; high turbidity; high organic content; high concentrations of SO_2, SO_3, and bisulfite; highly buffered samples Other: Amperometric forward titration using 0.00564 N PAO (Hatch). Method 9212 is for the analysis of simple chloride rather than total chloride.
	Air	Draeger gas detection tube	Draeger gas detection tube Chlorine 0.2/a (P/N CH24301); 0.3/b (P/N 6728411); 50/a (P/N CH20701) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection ranges 0.2 – 30 ppm; 0.3 – 10 ppm; 50 – 500 ppm Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
			EPA Method 26A (OAQPS)	Detection: Detection range 0.2 – 30 ppm; detection limit 0.1 µg/mL Interferences: Volatile materials, such as ClO_2 and NH_4Cl, which produce halide ions upon dissolution during sampling, are potential interferents Other: Collect gas/air in SUMMA canisters
2-Chloroethanol	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid	GC-MS	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples and Method 5035A for solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
2-Chloroethanol	Aqueous Liquid Drinking Water	GC-FTIR	EPA Method 8340 (SW-846)	Detection: Minimum identifiable quantity 120 ng Working Range: Working range 25 – 500 mg/L Sample Throughput: Run time 15 minutes Sample Preparation: Direct aqueous injection Interferences: Contaminants in solvents, reagents, glassware, and other sample processing hardware
	Air	GC-MS or -FID	Methods for the Determination of Hazardous Substances. 1997. 88: 1–20	Working Range: 1 – 1000 mg/m^3 Sample Preparation: Use Draeger diffusive sampler or sorbent tube (i.e, Anasorb® 747 or equivalent). Analyze sampler or sorbent tube with GC-MSD or FID (NIOSH 2513), etc. Interferences: High humidity may affect recovery Other: Limited QC for rapid analysis
	Aqueous Liquid Drinking Water	GC-FID (direct injection)	No Method Identified	–
	Air		EPA Method TO-8	Other: Aqueous impinger collection
3-Chloro-1,2-propanediol	Aqueous Liquid Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS-SPE	Food Additives and Contaminants. 2005. 22(12): 1189–1197	Sample Preparation: Elution from SPE column, Extrelut® 20 column, with ethyl acetate. Analysis by GC-MS at the low ng/µL level. Solids should be extracted with water prior to SPE. Other: Limited QC for rapid analysis
	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS-SPE	Journal of Chromatography A. 1992. 589: 109–119	Sample Preparation: Elution from SPE column, Extrelut® 20 column, with ethyl acetate. Analysis by GC-MS at the low ng/µL level. Other: Limited QC for rapid analysis
	Air	GC-MS	"1,3-Dichloro-2-propanol, Review of Toxicological Literature" NTP, January 2005 http://ntp.niehs.nih.gov/ntp/htdocs/Chem_Background/ExSumPdf/dichloropropanol.pdf (accessed November 19, 2009)	Sample Preparation: Collect sample in SUMMA canister per method Method TO-15 and analyze by GC-MS Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
3-Chloro-1,2-propanediol	Aqueous Liquid Drinking Water	GC-FID (direct injection)	No Method Identified	–
	Air		EPA Method TO-8	Other: Aqueous impinger collection
Chloropicrin	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water) or 5035A (solid) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples and Method 5035A for solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.
	Air	Automated thermal desorption GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Detection: Detection limit 50 ng/tube (full scan). S:N ratio at 50 ng/tube was ≥4:1. Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Samples can be analyzed only once Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)
Chlorosarin	Aqueous Liquid Drinking Water Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Chlorosarin	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for a similar compound (GB)
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
	Non-aqueous Liquid/Organic Solid	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HN, and CF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
Chlorosoman	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs were generally <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HN, and CF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
2-Chlorovinylarsonous acid (2-CVAA) (degradation product of Lewisite)	Aqueous Liquid Solid	GC-MS	Toxicology Methods. 1999. 9: 275–294	<u>Sample Preparation</u>: Aqueous sample is extracted on C18 column, eluted with MeOH, dried and derivatized with EDT, then shake and shoot <u>Other</u>: If chromatographic separation is not required, EDT can be omitted
	Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	<u>Detection</u>: Detection range 0.02 – 0.20 mg/L. Measures total arsenic. <u>Interferences</u>: Potential interferences include antimony salts <u>Other</u>: Silver diethyldithio-carbamate method.
	Non-aqueous Liquid/Organic Solid	GC-MS	Toxicology Methods. 1999. 9: 275–294	<u>Sample Preparation</u>: Dissolve in $MeCl_2$ and derivatize with EDT <u>Other</u>: If chromatographic separation is not required, EDT can be omitted
	Solid Wipes	GC-MS-SPME	Journal of Chromatography A. 2001. 909: 13–28	<u>Sample Throughput</u>: Total sample processing time ~5 minutes <u>Sample Preparation</u>: Soil samples are extracted using ascorbic acid in water with propanedithiol, centrifuged, and filtered. Analytes are concentrated from supernatant onto SPME fiber and detected by GC-MS.
	Air (particulates) Solid	X-ray fluorescence (fieldable)	EPA Method 6200 (SW-846)	<u>Detection</u>: Interference-free detection limit 40 mg/kg <u>Interferences</u>: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals <u>Other</u>: Measures total arsenic
	Air	Draeger gas detection tube (fieldable)	Sensors and Actuators B. 2005. 108: 193–197	<u>Detection</u>: Detection in the sub-mg/m^3 range <u>Sample Preparation</u>: Takes several minutes for coloration to occur (could lead to false positives) <u>Other</u>: Gives semi-qualitive information (i.e., can identify class of compound: phosphoric esters, organo-arsenic, thioether, cyanogen chloride, and cyanide)
Chlorpyrifos **Chlorpyrifos oxon**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water) or 5035A (solid) with 8260C (SW-846)	<u>Working Range</u>: Calibration range 1 – 100 mg/L <u>Sample Preparation</u>: Based on Method 8260 using Method 5030C for preparation of water samples and Method 5035A for solid samples <u>Interferences</u>: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation. Tested for similar compounds.
	Air	Automated thermal desorption GC-MS	Journal of Chromatography A. 2001. 925: 241–249	<u>Quantitation</u>: Semi-quantitative <u>Performance</u>: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% <u>Sample Throughput</u>: Samples can be analyzed only once <u>Sample Preparation</u>: Automated thermal desorption. Tube is connected to heated GC injector (100°C). <u>Other</u>: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Crimidine	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC	Journal of Chromatography A. 1996. 726: 99–113	Detection: Detection limit 0.1 µg/L Performance: Recovery 89% Sample Throughput: Retention time ~23.8 minutes Sample Preparation: Soil and non-aqueous liquid/organic solid samples require extraction into water Other: Diode array with online sample enrichment
		HPLC-ESI-MS-SIM	Analytica Chimica Acta. 2004. 505: 209–215	Sample Preparation: SPE. Soil and non-aqueous liquid/organic solid samples require extraction into water.
		MEKC	Electrophoresis. 2001. 22(11): 2260–2269	Detection: Detection limit 0.46 µg/L Quantitation: Quantitation limit 1 µg/L Sample Throughput: Retention time <2 minutes Sample Preparation: SPE and sample stacking. Soil samples require extraction into water.
Cyanide, Amenable to chlorination	Aqueous Liquid Drinking Water Solid Wipes	Spectrophotometry	EPA Method 3135.2I (EPA RLAB)	Detection: Detection range 0.003 – 0.500 mg/L (cyanide in the distilate) Sample Preparation: Acid digestion followed by distilation
		Spectrophotometry (fieldable)	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.001 – 0.240 mg/L Sample Preparation: All samples to be analyzed for cyanide should be treated by acid distillation except when experience has shown that there is no difference in results obtained with or without distillation Interferences: Interferences include high levels of Cl, Ni, Co >1 mg/L, Cu >20 mg/L, Fe >5 mg/L, or oxidizing agents. Remove metals by adding chelating reagents and remove oxidizing agents with appropriate reagents. Other: Pyridine-pyrazalone method

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Cyanide, Total	Air Aqueous Liquid Drinking Water Solid Wipes	Spectrophotometry (fieldable)	Hach Water Analysis Handbook. 5th Edition. 2008	<u>Detection</u>: Detection range 0.001 – 0.240 mg/L <u>Sample Preparation</u>: All samples to be analyzed for cyanide should be treated by acid distillation except when experience has shown that there is no difference in results obtained with or without distillation <u>Interferences</u>: Interferences include high levels of Cl, Ni, Co >1 mg/L, Cu >20 mg/L, Fe >5 mg/L, or oxidizing agents. Remove metals by adding chelating reagents and remove oxidizing agents with appropriate reagents. <u>Other</u>: Pyridine-pyrazalone method
	Solid Wipes	EM Quant® Cyanide Test (fieldable)	EM Quant® Cyanide Test, Catalog (P/N 10044) <u>http://www.galladechem.com/</u> (accessed November 19, 2009)	<u>Detection</u>: 1 – 30 mg/L <u>Sample Preparation</u>: Soil is extracted into water <u>Interferences</u>: Complexed cyanides and cyanides of Cu, Pd, Hg, and Ag give low readings or are not detected at all
		Draeger gas detection tube (fieldable)	Draeger gas detection tube Cyanogin chloride 0.25/a (P/N CH19801) <u>http://www.afcintl.com/pdf/draeger/CH19801.pdf</u> (accessed November 19, 2009)	<u>Detection</u>: Detection range 0.25 – 5 ppm <u>Performance</u>: Standard deviation is ±30% <u>Sample Throughput</u>: Measurement time ~five minutes <u>Interferences</u>: Interferences include cyanogen bromide
			Sensors and Actuators B. 2005. 108: 193–197	<u>Detection</u>: Detection range in the sub-mg/m^3 range <u>Sample Throughput</u>: Takes several minutes for tube coloration to occur <u>Other</u>: Gives semi-qualitive information (i.e., can identify class of compound: phosphoric esters, organo-arsenic, thioether, cyanogen chloride, and cyanide)
	Air	Draeger gas detection tube (fieldable)	Draeger gas detection tube Cyanide 2/a (P/N 6728791) <u>http://www.draeger.com/US/en_US/</u> (accessed November 19, 2009)	<u>Detection</u>: Detection range 2 – 15 mg/m^3 <u>Sample Preparation</u>: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	<u>Detection</u>: Detection range 0.01 – 0.50 mg/L <u>Interferences</u>: Potential interferences include formaldehyde, sulfite, thiocyanate, and cyanide. <u>Other</u>: Cyanogen chloride method

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Cyanogen chloride	Aqueous Liquid Drinking Water	GC-MSD	EPA Method 524.2 (OW)	Sample Preparation: For soil samples, extract with water, purge, and trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures because of thermal degradation.
	Air	Portable GC-MS (fieldable)	Sensors and Actuators B. 2005. 108: 193–197	Detection: Detection limit 100 mg/m^3 (in the no-GC separation mode) Interferences: Potential interferences include Cl, Cu >20 mg/L, Fe >5 mg/L, oxidizing agents, and reducing agents (these interferences can be eliminated by treatment)
		Draeger gas detection tube (fieldable)	Draeger gas detection tube Cyanogen chloride 0.25/a (P/N CH19801) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection range 0.25 – 5 ppm Sample Throughput: ~5 minutes per measurement Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent) Interferences: Cross sensitivity to cyanogen bromide
			Draeger gas detection tube Cyanogen chloride 0.25/a (P/N CH19801) http://www.afcintl.com/pdf/draeger/CH19801.pdf (accessed November 19, 2009)	
Cyclohexyl sarin (GF)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Recovery for GF 89 (±5)% (water); 74 (±10)% (soil) Sample Throughput: Samples can be analyzed only once Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Detection: Detection limit 50 ng/tube (full scan). S:N ratio at 50 ng/tube was ≥4:1. Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Retention time ~9.5 minutes. Samples can be analyzed only once. Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Cyclohexyl sarin (GF)	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
		Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
1,2-Dichloroethane (degradation product of HD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic solid Solid	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limit 5 µg/kg (wet weight) for soil/sediment; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260, use Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. May require low injection port temperatures due to thermal degradation. Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Aqueous Liquid Solid	GC-FID or -MSD	NIOSH Method 1003	Sample Preparation: Collect sample headspace on sorbent tube for analysis using GCD-FID or GC-MSD
	Aqueous Liquid Drinking Water	GC-MS (purge and trap)	EPA Method 524.2 (OW)	Detection: Detection limit 0.06 µg/L Performance: Mean accuracy of 0.1 – 10 µg/L with RSD of 5.4% Interferences: Volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. May require low injection port temperatures due to thermal degradation. Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Air	GC-MS	Field Analytical Chemistry and Technology. 1998. 2(1): 3–20	Detection: Detection limit 0.81 ppb Quantitation: Quantitation/qualifier ions 62, 49, 64 Sample Throughput: Elution time using TO-14 gas mix 8.0 minutes; total time 15 minutes Other: Using VOCARB® 3000 Trap or equivalent
		GC-FID	EPA Method TO-3 (ORD)	Other: Tedlar® bag method. Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Dichlorvos	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
Dicrotophos	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water) or 5035A (solid) with 8260C (SW-846)	Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples and Method 5035A for solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation. Tested for similar compounds.
	Air	Automated thermal desorption GC-MS	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Samples can be analyzed only once Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Diesel range organics	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic solid Solid Wipes	GC-MS	EPA Method 8015C (SW-846)	Sample Preparation: Disolve in $MeCl_2$, shake and shoot Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Diisopropyl methylphosphonate (DIMP) (degradation product of GB)	Aqueous Liquid Drinking Water Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
Dimethylphosphite	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Dimethylphosphite	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
Dimethylphosphoramidic acid (degradation product of GA)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-APCI-MS-SIM	Journal of Chromatography A. 1999. 862(2): 169–177	Detection: Detection limit ≤100 ng/mL Sample Throughput: Retention time ~1.5 minutes Sample Preparation: Water samples can be analyzed directly. Soil and non-aqueous liquid/organic solid samples are extracted with water, filtered, and analyzed. Other: Tested for similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	HPLC-MS	Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Diphacinone	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-UV	Chemosphere. 2005. 61: 1580–1586	Detection: UV wavelength 310 nm Sample Preparation: Filtration, requires no extraction Other: Tested for similar compounds
		HPLC-APCI-MS-SPE	"A General Unknown Screening For Drugs and Toxic Compounds in Human Serum." Thesis. http://pages.unibas.ch/diss/2005/DissB_7295.pdf (accessed November 19, 2009)	Sample Preparation: SPE cartridge extraction Other: Tested for similar compounds
		HPLC-APCI-MS-LLE	Journal of Chromatography B. 1999. 731: 155–165	Sample Preparation: Extraction with ethyl acetate and evaporation to dryness, followed by redissolving in acetonitrile Other: Tested for similar compounds

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Disulfoton **Disulfoton sulfoxide**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: $MeCl_2$ extraction Other: Tested for similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid	Fluorescence with or without HPLC	Chemosphere. 2005. 61: 1580–1586	Other: Tested for similar compounds
	Air	GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system.
1,4-Dithiane (degradation product of HD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limit 5 μg/kg (wet weight) for soil/sediment; 0.5 mg/kg (wet weight) for wastes; 5 μg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 μg/L (water); 5 μg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. May require low injection port temperatures due to thermal degradation. Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Aqueous Liquid Drinking Water Solid Wipes	GC-MS (fieldable)	Field Analytical Chemistry and Technology. 1998. 2(1): 3–20	Sample Preparation: Amount injected 2.6 ng
	Aqueous Liquid Drinking Water	GC-MS (purge and trap)	EPA Method 524.2 (OW)	Detection: Detection limit 0.06 μg/L Performance: Mean accuracy of 0.1 – 10 μg/L is 95% with RSD of 5.4% Interferences: Volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. May require low injection port temperatures due to thermal degradation. Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
EA2192 [Diisopropylaminoethyl methylthiolophosphonate] (hydrolysis product of VX)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-ESI-MS-SIM	Journal of Chromatography. 1998. 794: 234–244	Detection: Detection limits are two times lower than for LC-APCI-MS-SIM method Sample Throughput: Retention time ~5.1 minutes Sample Preparation: Water samples can be analyzed directly. Soil samples and non-aqueous liquid/organic solid samples are extracted with water, filtered, and analyzed. Other: Tested for similar compound (ethylmethyl phosphonate). Limited QC for rapid analysis (an instrument blank and instrument tune, but no calibration standards).
	Air	HPLC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Ethyl methylphosphonic acid (EMPA) (degradation product of VX)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-ESI-MS-SIM	Journal of Chromatography. 1998. 794: 234–244	Detection: Detection limits are two times lower than for LC-APCI-MS-SIM method Sample Throughput: Retention time ~5.1 minutes Sample Preparation: Water samples can be analyzed directly. Soil samples and non-aqueous liquid/organic solid samples are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Air	HPLC-MS	Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Ethyldichloroarsine (ED)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Recovery for water 92 – 97%; recovery for soil 30 – 73% Sample Preparation: Filtration, acidification, addition of 2,4-DMT and acetone extraction Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). Has been tested on a similar compound (Lewisite 3). Limited QC for rapid analysis (possibly a blank and an instrument tune, but no standards).

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Ethyldichloroarsine (ED)	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 0.20 mg/L. Measures total arsenic. Interferences: Potential interferences include antimony salts Other: Silver diethyldithio-carbamate method
	Air (particulates) Solid Wipes	Portable X-ray fluorescence	EPA Method 6200 (SW-846)	Detection: Inteference-free detection limits 40 mg/kg. Measures total arsenic. Interferences: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
N-Ethyldiethanolamine (EDEA) (degradation product of HN-1)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	LC-MS	Journal of Chromatography A. 2006. 1102: 214–223	Sample Preparation: Soils and non-aqueous liquid/organic solid should first be extracted into water Other: A liquid chromatograph with mixed mode column and isocratic elution gave good chromatography
	Air	HPLC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Ethylene oxide	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035 (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Ethylene oxide	Air	Draeger gas detection tube	Draeger gas detection tube Ethylene Oxide 1/a (P/N 6728961) http://www.afcintl.com/pdf/draeger/6728961.pdf (accessed November 19, 2009)	Detection: Detection ranges 1 – 15 ppm; 25 – 500 ppm Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
			Draeger gas detection tube Ethylene Oxide 1/a (P/N 6728961); 25/a (P/N 6728241) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	
		GC-FID	EPA Method TO-8	Other: EPA Method TO-8 modified for direct injection
		GC-MSD	EPA Method TO-15 (ORD)	Sample Preparation: Canister sample Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Fenamiphos	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: $MeCl_2$ extraction Other: Tested for similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Fentanyl	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-UV	Chemosphere. 2005. 61: 1580–1586	Sample Preparation: Filtration, requires no extraction
		HPLC-APCI-MS-SPE	"A General Unknown Screening For Drugs and Toxic Compounds in Human Serum." Thesis. http://pages.unibas.ch/diss/2005/DissB_7295.pdf (accessed November 19, 2009)	Sample Preparation: SPE cartridge extraction
		HPLC-APCI-MS-LLE	Journal of Chromatography B. 1999. 731: 155–165	Sample Preparation: Extraction with ethyl acetate and evaporation to dryness, followed by redissolving in acetonitrile
		Immunoassay	Journal of Analytical Toxicology. 1990. 14(3): 160–164	Detection: 0.25 ng/mL
	Aqueous Liquid	Fluorescence with or without HPLC	Chemosphere. 2005. 61: 1580–1586	Other: Tested for similar analyte(s) (bromadiolone)
Fluoride	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 2.00 mg/L Interferences: This test is sensitive to small amounts of interference; glassware must be very clean (acid rinse before each use) Other: SPADNS reagent
	Aqueous Liquid Drinking Water	Ion Selective Electrode	EPA Method 9214 (SW-846)	Detection: Detection range 0.025 – 500 mg/L; detection limit 0.5 mg/L Interferences: Polyvalent cations (i.e., Fe^{3+} and Al^{3+}) Other: This method measures simple fluoride rather than total fluoride
Fluoroacetamide	Air Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Journal of Chromatography B. 2008. 876(1): 103–108	Detection: Detection limit 0.01 µg/mL Quantitation: Quantitation limit 0.03 µg/mL Working Range: 0.03 – 30 µg/mL Sample Preparation: Acetonitrile extraction

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Fluoroacetic acid and fluoroacetate salts (analyze for fluoroacetate ion)	Air Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS or -ECD	Analytical Letters. 1997. 27(14): 2703–2718	Detection: Detection range 0.02 – 2.00 mg/L Sample Preparation: Solid and non-aqueous liquid/organic samples are extracted ultrasonically with water, then partitioned with hexane and acidified prior to re-extraction with ethyl acetate. Aqueous and drinking water samples are partitioned with hexane, and acidified prior to re-extraction with ethyl acetate. The ethyl acetate fraction is taken to dryness in the presence of TEA, and the resulting acid is derivatized with pentafluorobenzyl bromide.
2-Fluoroethanol	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid	GC-MS	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples and Method 5035A for solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.
	Aqueous Liquid Drinking Water	GC-FTIR	EPA Method 8340 (SW-846)	Detection: Minimum identifiable quantity 120 ng Working Range: Working range 25 – 500 mg/L Sample Throughput: Run time 15 minutes Sample Preparation: Direct aqueous injection Interferences: Contaminants in solvents, reagents, glassware, and other sample processing hardware
		GC-FID (direct injection)	No Method Identified	–
	Air	GC-MS or -FID	Methods for the Determination of Hazardous Substances. 1997. 88: 1–20	Working Range: 1 – 1000 mg/m^3 Sample Preparation: Use Draeger diffusive sampler or sorbent tube (i.e, Anasorb® 747 or equivalent). Analyze sampler or sorbent tube with GC-MSD or FID (NIOSH 2513), etc. Interferences: High humidity may affect recovery Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		GC-FID (direct injection)	EPA Method TO-8 (ORD)	Other: Aqueous impinger collection

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Formaldehyde	Aqueous Liquid Drinking Water Solid Wipes	HPLC-UV	EPA Method 8315A (SW-846)	Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 3 – 500 µg/L Quantitation: Results measured at 630 nm Sample Preparation: Formaldehyde reacts with MBTH and a developing solution to form a blue color in proportion to the formaldehyde concentration
	Air	Draeger gas detection tube	Draeger accuro® pump kit and gas detection tube http://www.coleparmer.com/catalog/product_view.asp?sku=8651434 (accessed November 19, 2009)	Detection: Detection ranges 0.2 – 5 ppm; 2 – 40 ppm Quantitation: RSD ±20 – 30% Sample Throughput: Measurement time ~1.5 minutes Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
			Draeger gas detection tube Formaldehyde 0.2/a (P/N 6733081); 2/a (P/N 8101751) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	
			Draeger gas detection tube Formaldehyde 0.2/a (P/N 6733081) http://www.afcintl.com/pdf/draeger/6733081.pdf (accessed November 19, 2009)	

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Gasoline range organics	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	Aqueous Liquid Drinking Water	HPTLC-AMD	Analytical Chemistry. 1994. 66: 2570–2577	Sample Throughput: Up to 20 samples can be chromatographed simultaneously
		Rapid HPLC	Journal of Forensic Science. 2005. 49(6): 1181–1186	Sample Throughput: Rapid version of this technique can separate seven explosives in <2 minutes Other: This procedure is based on a method for soil analyses, but could be modifed to analyze water matrices
	Non-aqueous Liquid/Organic Solid	Fast GC-PDECD or -MS	Journal of Forensic Science. 2006. 51: 815	Sample Throughput: Nine explosives could be detected in under three minutes Sample Preparation: No sample preparation method was investigated; Method 8330 is recommended for solids, and Method 3535 is recommended for liquids
	Non-aqueous Liquid/Organic Solid	GC-MS	Poster: "Detection of Explosives by Fast GC - Fast MS using an Ion Trap"	–
	Non-aqueous Liquid/Organic Solid	Rapid TLC (fieldable)	Chemistry for the Protection of the Environment 4. 2003. 59: 125–135	Quantitation: Semi-quantitative
	Solid Wipes	Immunoassay	EPA Method 4050 (SW-846)	Detection: Detection limit >500 ppm Other: Designed to detect TNT
			EPA Method 4051 (SW-846)	Detection: Detection limit 5 ppb Performance: +99% of soil samples containing 1.0 ppm will produce a positive result
		Fast GC-PDECD or -MS	Journal of Forensic Science. 2006. 51: 815	Sample Throughput: Nine explosives detected in <3 minutes Sample Preparation: No sample preparation method was investigated; Method 8330 is recommended for solids, and Method 3535 is recommended for liquids
		GC-MS	Poster: "Detection of Explosives by Fast GC - Fast MS using an Ion Trap"	Sample Throughput: Nine explosives detected in <3 minutes Sample Preparation: No sample preparation method was investigated; Method 8330 is recommended for solids, and Method 3535 is recommended for liquids

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	Solid Wipes	Rapid TLC (fieldable)	Chemistry for the Protection of the Environment 4. 2003. 59: 125–135	Quantitation: Semi-quantitative
			Journal of Forensic Science. 2005. 49(6): 1181–1186	Quantitation: Semi-quantitative Sample Throughput: A rapid version of this technique can separate seven explosives in <2 minutes Other: Procedure is based on a method for soil analyses, but could be modifed to analyze water matrices.
		Colorimetric screening	EPA Method 8515 (SW-846)	Detection: Detection of TNT at concentrations >1 ppm. 95% of samples containing 0.7 ppm of TNT or less will produce a negative result. Working Range: 1 – 30 ppm (TNT) Sample Preparation: Sample is treated with color-change reagents and read in spectrophotometer Performance: Average recovery for 5 ppm spike (n=22) 5.1 (±0.4) ppm with 7.8% RSD
			EPA Method 8510 (SW-846)	Detection: Detection of TNT at concentrations >1 ppm. 95% of samples containing 0.7 ppm of TNT or less will produce a negative result. Working Range: 1 – 30 ppm (TNT)
Hexamethylenetriperoxidediamine (HMTD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	DESI mass spectrometry	Chemistry Communications. 2006. 93: 953–955	Other: Tested for similar compound (TATP). DESI mass spectrometry is used for detection of trace amounts of TATP by alkali metal complexation.
		HPLC	Analytical Chemistry. 2003. 75(4): 731–735	Detection: Limit of detection 5 µmol/L Sample Throughput: Allows field testing with readily available and portable instrumentation Sample Preparation: Substances and interferences are separated on a C-18 column, the analytes are subsequently decomposed to hydrogen peroxide by UV irradiation, and detected fluorometrically based on HRP-catalyzed oxidative coupling of phenols by hydrogen peroxide Other: Detects TATP and HMTD; post-column photochemical treatment and fluorescence detection
Hydrogen bromide	Air	Gas detection tube	OSHA Method ID-165SG	Detection: Detection limit 0.20 µg (based on a sample volume of 10 mL and an injection volume of 100 µL) Working Range: 0.2 – 50 µg/mL Performance: The average coefficient of variation is 0.035 Sample Preparation: A known volume of air is drawn through a silica gel tube. H_2SO_4, H_3PO_4 and other particulates are collected on the glass fiber plug while HBr and HNO_3 are collected on the silica gel sorbant.
		Impinger collection or ion selective electrode	EPA Method TO-8 (ORD); EPA Method 9211 (SW-846)	Detection: Detection range 0.1 – 1000 mg/L; detection limit 0.2 mg/L Sample Throughput: This procedure may be more cumbersome than silica gel collection Interferences: Polyvalent cations (i.e., Fe^{3+} and Al^{3+}) Other: Method 9211 for the analysis of simple bromide ion rather than total bromide
Hydrogen chloride	Air	IC	OSHA Method ID-174SG	Sample Preparation: Collect air sample on silica gel tubes

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Hydrogen chloride	Air	Draeger gas detection tube	Draeger gas detection tube Hydrochloric Acid 1/a (P/N CH29501) http://www.afcintl.com/pdf/draeger/CH29501.pdf (accessed November 19, 2009)	Detection: Detection ranges 1 – 10 ppm; 50 – 5,000 ppm Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
			Draeger gas detection tube Hydrochloric Acid 1/a (P/N CH29501); 50/a (P/N 6728181) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	
		Impinger collection or ion selective electrode	EPA Method TO-8 (ORD); EPA Method 9212 (SW-846)	Detection: Detection range 0.4 – 1000 mg/L; detection limit 2.0 mg/L Interferences: Polyvalent cations (Fe^{3+} and Al^{3+}) Sample Throughput: This procedure may be more cumbersome than silica gel collection Other: Method is for the analysis of simple chloride rather than total chloride
Hydrogen cyanide	Air	Toxic gas detector	General Monitors toxic gas detectors http://www.generalmonitors.com/products/toxic_gasdetectors.html (accessed November 19, 2009)	Detection: Detection range 0 – 20 ppm
	Aqueous Liquid Drinking Water	Spectrophotometry (fieldable)	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.001 – 0.240 mg/L Interferences: Interferences include high levels of Cl, Ni, Co >1 mg/L, Cu >20 mg/L, Fe >5 mg/L, or oxidizing agents. Remove metals by adding chelating reagents and remove oxidizing agents with appropriate reagents. Other: Pyridine-pyrazalone spectrophotometer
Hydrogen fluoride	Air	Draeger/Nextteq Gastec® gas detection tube (fieldable)	Nextteq Gastec® Hydrogen Fluoride (P/N 19026210) https://www1.fishersci.com/Coupon;jsessionid=EoYtTAmK7vdGN1Njc1v909NF0wtwNAeoJtfcJFfuD1Khfn5XdteN!-43026010?cid=1342&gid=2444789&details=Y (accessed November 19, 2009)	Detection: Detection ranges 0.25 – 100 ppm; 0.5 – 90 ppm Working Range: Working range 0.25 – 100 ppm

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Hydrogen fluoride	Air	Draeger/Nextteq Gastec® gas detection tube (fieldable)	Draeger gas detection tube Hydrogen Fluoride 0.5/a (P/N 8103251) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection ranges 0.25 – 100 ppm; 0.5 – 90 ppm Working Range: Working range 0.25 – 100 ppm
		Impinger collection	EPA Method TO-8 (ORD); EPA Method 9214 (SW-846)	Detection: Detection range 0.025 – 500 mg/L; detection limit 0.5 mg/L Sample Throughput: This procedure may be more cumbersome than silica gel collection Interferences: Polyvalent cations (i.e., Fe^{3+} and Al^{3+}) Other: This method measures simple fluoride rather than total fluoride
Hydrogen sulfide	Air	GC-FID or -ECD	EPA field screening Method FM9	Other: Used to screen water, air, soil, and sediment samples on a GC with a PID, FID, or ECD. Air screened directly by collecting sample and injecting into GC for analysis.
		Nextteq Gastec® gas detection tube (fieldable)	Nextteq Gastec® gas detection tube Hydrogen Sulfide (P/Ns 19026294, 19026293, 19026291, 19026286) https://www1.fishersci.com/Coupon;jsessionid=EoYtTAmK7vdGN1Njc1v909NF0wtwNAeoJtfcJFfuD1Khfn5XdteN!-1343026010?cid=1342&gid=2444789&details=Y (accessed November 19, 2009)	Detection: Detection ranges from 0.1 – 4 ppm to 10 – 4000 ppm
		Draeger gas detection tube	Draeger gas detection tube Hydrogen Sulfide 0.2/a (P/N 8101461); 0.2/b (P/N 8101991); 0.5/a (P/N 6728041); 1/d (P/N 8101831); 2/a (P/N 6728821); 2/b (P/N 8101961); 5/b (P/N CH29801) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection ranges from 0.1 – 4 ppm to 10 – 4000 ppm
		UV-luminescence detector	Environmental technology verification report Horiba Instruments APSA-360 Ambient Hydrogen Sulfide Analyzer http://www.epa.gov/etv/pubs/01_vr_apsa360.pdf (accessed November 19, 2009)	Detection: Detection range 4 – 300 ppb Quantitation: Recovery 131% Interferences: Interferences include carbanyl sulfide, dimethyl sufide, and methyl mercaptan

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Hydrogen sulfide	Air	Toxic Gas Leak detector (fieldable)	CEA HS-2200 Toxic Gas Leak Detector http://www.ceainstr.com/pdf_datasheets/seriesu_Info.pdf (accessed November 19, 2009)	Detection: Detection ranges 0 – 50 ppm; 0 – 100 ppm; 0 – 500 ppm; 0 – 1000 ppm
		Portable H_2S Analyzer (fieldable)	Arizona Instruments Jerome® 631-X Portable Handheld H_2S Analyzer http://www.trs-environmental.com/Model/AZI_X631_H2S_ANALYZER.aspx (accessed November 19, 2009)	Detection: Detection range 0.003 – 50 ppm
		GC-FID or -ECD	EPA Method TO-15	Other: Modified to include Tedlar® bags with limited QC to ensure rapid sample screening
Isopropyl methylphosphonic acid (IMPA) (degradation product of GB)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	LC-ESI-MS-SIM	Journal of Chromatography. 1998. 794: 234–244	Detection: Detection limits are two times lower than for LC-APCI-MS-SIM Sample Throughput: Retention time ~10.9 minutes Sample Preparation: Water samples can be analyzed directly. Soil samples and non-aqueous liquid/organic solid are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		LC-APCI-MS-SIM	Journal of Chromatography A. 1999. 862(2): 169–177	Detection: Detection limits ≤10 ng/mL Sample Throughput: Retention time ~3.9 minutes Sample Preparation: Water samples can be analyzed directly. Soil and non-aqueous liquid/organic soild samples are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Air	HPLC-MS	Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Kerosene	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	EPA Method 8015C (SW-846)	Sample Preparation: $MeCl_2$ extraction Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Lead arsenate (analyze as total arsenic)	Air (particulates) Solid Wipes	X-ray fluorescence analyzer (fieldable)	EPA Method 6200 (SW-846)	<u>Detection</u>: Interference-free detection limit 40 mg/kg (arsenic) <u>Quantitation</u>: Semi-quantitative <u>Interferences</u>: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	<u>Detection</u>: Detection range 0.02 – 0.20 mg/L (arsenic) <u>Interferences</u>: Potential interferences include antimony salts <u>Other</u>: Measures total arsenic. Silver diethyldithio-carbamate method.
	Non-aqueous Liquid/Organic Solid	ICP-MS	EPA Method 6020A (SW-846); EPA Method 200.8 (OW)	<u>Detection</u>: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES <u>Sample Preparation</u>: Extraction in aqueous nitric acid <u>Other</u>: Limited QC for rapid analysis
		ICP-AES	EPA Method 6010C (SW-846); EPA Method 200.7 (OW)	<u>Detection</u>: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES <u>Sample Preparation</u>: Extraction in aqueous nitric acid <u>Other</u>: Limited QC for rapid analysis
Lewisite 1 (L-1) [2-chlorovinyldichloroarsine] (analyze for total arsenic)	Air (particulates) Solid Wipes	Portable X-ray fluorescence	EPA Method 6200 (SW-846)	<u>Detection</u>: Inteference-free detection limit 40 mg/kg (measures total arsenic) <u>Interferences</u>: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	<u>Performance</u>: May have limited application for detection of Lewisite 1. Recovery for water 92 – 97%; for soil 30 – 73%. <u>Sample Preparation</u>: Filtration, acidification, addition of 2,4-DMT and acetone extraction <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). Has been tested on a similar compound (Lewisite 3).
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	<u>Detection</u>: Detection range 0.02 – 0.20 mg/L. Measures total arsenic. <u>Interferences</u>: Potential interferences include antimony salts <u>Other</u>: Silver diethyldithio-carbamate method
	Air	Surface acoustic wavelength detector (fieldable)	Sensors and Actuators B. 2005. 108: 193–197	<u>Detection</u>: Detection limit 40 mg/m^3 (cannot distinguish between mustard and Lewisite) <u>Quantitation</u>: Gives semi-qualitative information <u>Other</u>: JCAD surface acoustic wavelength detector
		Draeger gas detection tube (fieldable)	Sensors and Actuators B. 2005. 108: 193–197	<u>Detection</u>: Detection in the sub-mg/m^3 range <u>Sample Throughput</u>: Takes several minutes for tube coloration to occur. Could lead to false positives. <u>Other</u>: Gives semi-qualitative information (i.e., can identify class of compound: phosphoric esters, organo-arsenic, thioether, cyanogen chloride, and cyanide)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Lewisite 1 (L-1) [2-chlorovinyldichloroarsine] (analyze for total arsenic)		Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system.
Lewisite 2 (L-2) [bis(2-chlorovinyl)-chloroarsine] (analyze for total arsenic)	Aqueous Liquid Drinking Water	Spectrophotometry (fieldable)	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 0.20 mg/L Interferences: Potential interferences include antimony salts; measures total arsenic Other: Silver diethyldithio-carbamate method. Hach DR/4000 and 2500 photometer.
	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: Filtration, acification, addition of 2,4-DMT and acetone extraction Other: Tested for similar compound (Lewisite 1)
			Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Detection: May have limited application for detection of Lewisite 2 Sample Preparation: $MeCl_2$ extraction Other: Has been tested on a similar compound (Lewisite 3). Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air (particulates) Solid Wipes	X-ray fluorescence (fieldable)	EPA Method 6200 (SW-846)	Detection: Interference-free detection limit 40 mg/kg (measures total arsenic) Interferences: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentrations of other heavy metals
	Air	Draeger gas detection tube (fieldable)	Sensors and Actuators B. 2005. 108: 193–197	Detection: Detection in the sub-mg/m^3 range Sample Throughput: Takes several minutes for tube coloration to occur. Could lead to false positives. Other: Gives semi-qualitative information (i.e., can identify class of compound: phosphoric esters, organo-arsenic, thioether, cyanogen chloride, and cyanide)
		Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Lewisite 3 (L-3) [tris(2-chlorovinyl)-arsine] (analyze for total arsenic)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	<u>Performance</u>: Recoveries in water ranged from 54 – 55%; soil recoveries ranged from 30 – 78% <u>Sample Preparation</u>: $MeCl_2$ extraction <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). Has been tested on a similar compound (Lewisite 3).
	Air (particulates) Solid Wipes	Portable X-ray fluorescence (fieldable)	EPA Method 6200 (SW-846)	<u>Detection</u>: Interference-free detection limit 40 mg/kg. Measures total arsenic. <u>Interferences</u>: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	<u>Detection</u>: Detection range 0.02 – 0.20 mg/L. Measures total arsenic. <u>Interferences</u>: Potential interferences include antimony salts <u>Other</u>: Silver diethyldithio-carbamate method
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	<u>Sample Throughput</u>: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. <u>Sample Preparation</u>: SPME sampling and thermal desorption <u>Interferences</u>: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. <u>Other</u>: Tested for similar compounds
Lewisite oxide (degradation product of Lewisite)	Air (particulates) Solid	Portable X-ray fluorescence (fieldable)	EPA Method 6200 (SW-846)	<u>Detection</u>: Interference-free detection limit 40 mg/kg. Measures total arsenic. <u>Interferences</u>: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water	GC-MS	Toxicology Methods. 1999. 9: 275–294	<u>Sample Preparation</u>: Aqueous sample is extracted on C18 column, eluted with methanol, dried, and derivatized with EDT. If chromatographic separation is not required then EDT can be omitted.
		Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	<u>Detection</u>: Detection range 0.02 – 0.20 mg/L <u>Interferences</u>: Potential interferences include antimony salts; measures total arsenic <u>Other</u>: Silver diethyldithio-carbamate method
		GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	<u>Performance</u>: Recovery range for water 92 – 94%; for soil 35 – 71% <u>Sample Preparation</u>: Filtration, acidification, addition of 2,4-DMT and acetone extraction <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Lewisite oxide (degradation product of Lewisite)	Non-aqueous Liquid/Organic Solid	GC-MS	Toxicology Methods. 1999. 9: 275–294	Sample Preparation: $MeCl_2$ extraction. Derivatize with EDT. If chromatographic separation is not required, then EDT can be omitted.
	Solid Wipes	GC-MS-SPME	Journal of Chromatography A. 2001. 909: 13–28	Sample Throughput: Total sample processing time ~5 minutes Sample Preparation: Samples are extracted (using ascorbic acid in water with propanedithiol), centrifuged, and filtered. Analytes are concentrated from supernatant onto SPME fiber and analyzed by GC-MS.
	Air	Draeger gas detection tube	Sensors and Actuators B. 2005. 108: 193–197	Detection: Detection is in the sub-mg/m^3 range Sample Throughput: Takes several minutes for tube coloration to occur. Could also lead to false positives. Other: Gives semi-qualitive information (i.e., can identify class of compound: phosphoric esters, organo-arsenic, thioether, cyanogen chloride, and cyanide)
Mercuric chloride (analyze for total mercury)	Aqueous Liquid Drinking Water Solid Wipes	Spectrophotometry	EPA Method 7473 (SW-846)	Detection: Detection limit 0.01 ng (total mercury) Working Range: Working range 0.05 – 600 ng Sample Throughput: Analysis time <5 minutes Interferences: Inteferfences include memory effects from high concentration samples Other: Thermal decomposition, desorption, and atomic absorption
	Aqueous Liquid Drinking Water		Mercury Tracker 3000 IP Portable Mercury Vapor Detector http://www.mercury-instrumentsusa.com/TrackerIP.htm (accessed November 19, 2009)	Detection: Detection limit 0.1 µg/m^3; detection range 0.1 – 2000 µg/m^3
			Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.1 – 2.5 µg/L Sample Throughput: >2 hours Interferences: No known interferences Other: Cold vapor method
	Air	Nextteq Gastec® gas detection tube (fieldable)	Nextteq Gastec® gas detection tube Mercury Vapor (P/N 19026282) https://www1.fishersci.com/Coupon;jsessionid=EoYtTAmK7vdGN1Njc1v909NF0wtwNAeoJtfcJFfuD1Khfn5XdteN!-1343026010?cid=1342&gid=2444789&details=Y (accessed November 19, 2009)	Detection: Detection range 0.05 – 13.2 mg/m^3

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Mercury, Total	Aqueous Liquid Drinking Water Solid Wipes	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.1 – 2.5 µg/L Sample Throughput: >2 hours Interferences: No known interferences Other: Cold vapor method
			EPA Method 7473 (SW-846)	Detection: Instrument detection limit 0.01 ng (total mercury) Working Range: Working range 0.05 – 600 ng Sample Throughput: Analysis time <5 minutes Interferences: Memory effects from high concentration samples Other: Thermal desorption
	Air	Nextteq Gastec® gas detection tube (fieldable)	Nextteq Gastec® gas detection tube Mercury Vapor (P/N 19026282) https://www1.fishersci.com/Coupon;jsessionid=EoYtTAmK7vdGN1Njc1v909NF0wtwNAeoJtfcJFfuD1Khfn5XdteN!-1343026010?cid=1342&gid=2444789&details=Y (accessed November 19, 2009)	Detection: Detection range 0.05 – 13.2 mg/m^3
		Draeger gas detection tube (fieldable)	Draeger gas detection tube Mercury Vapor 0.1/b (P/N CH23101) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection range 0.05 – 2 mg/m^3
		Spectrophotometry	Mercury Tracker 3000 IP Portable Mercury Vapor Detector http://www.mercury-instrumentsusa.com/TrackerIP.htm (accessed November 19, 2009)	Detection: Detection limit 0.1 µg/m^3; detection range 0.1 – 2000 µg/m^3
		EPA M30B Carbon Trap	EPA Method 30B (OAQPS)	Detection: Detection range 0.1 µg/dscm to >50 µg/dscm
		Lumex Mercury Analyzers	Lumex Mercury Analyzers (including direct read gas only model) http://www.ohiolumex.com (accessed November 19, 2009)	Detection: Detection limit 2 ng/m^3 Working Range: 0.00001 – 0.1 mg/m^3

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Mercury, Total	Air	Jerome® Mercury Vapor Analyzer	Arizona Instruments Jerome® 411 Mercury Vapor Analyzer http://www.azic.com/pdf/manual_SS-101.pdf (accessed November 19, 2009)	Detection: Detection Range 0.000 – 1.999 mg/m^3 Performance: ±5% at 0.107 mg/m^3 Hg
Methamidophos	Air Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC	Journal of Chromatography A. 2007. 1154(1): 3–25	Quantitation: 0.01 mg/kg (limit of quantification) Working Range: 0.01 – 1.0 mg/kg Performance: Mean recovery range 70 – 110 (±15)% Sample Throughput: Retention time 4.70 minutes
	Aqueous Liquid Drinking Water		Chromatographia. 2006. 63(5/6): 233–237	Detection: Detection limit 30 µg/L Performance: Recovery range 95.3 – 118.4 % Sample Throughput: Retention time 4.39 minutes
Methomyl	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	Immunoassay (fieldable)	RaPID Assay® Methomyl (built to order) http://www.sdix.com (accessed November 19, 2009)	Detection: Detection level 0.45ppb (as methomyl) Quantitation: Quantitation between 1.0 – 15.0 ppb Other: Used as a quantitative, semi-quantitative, or qualitative enzyme immunoassay for the analysis of methomyl in water
		HPLC-ESI-MS-SIM	Analytica Chimica Acta. 2004. 505: 209–215	Sample Preparation: SPE, soil samples, and non-aqueous liquid samples require extraction into water
		HPLC	Journal of Chromatography A. 1996. 726: 99–113	Detection: Detection limit 0.5 µg/L Performance: Recovery 19% Sample Throughput: Retention time ~12.8 minutes Sample Preparation: Soil samples and non-aqueous liquid samples require extraction into water Other: Diode array with online sample enrichment
	Air	HPLC-UV	NIOSH Method 5601	Detection: Detection limit 0.05 µg/L Working Range: 1 – 10 µg/L Sample Preparation: Collect air samples on sorbents. Extraction with 0.2% v/v 0.1 M aqueous triethylamine phosphate buffer in acetonitrile (pH 6.9 – 7.1) from filter/solid sorbent tube (OVS-2 Tube: 13-mm quartz fiber filter; XAD-2, 270 mg/140 mg)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Methoxyethylmercuric acetate (analyze for total mercury)	Aqueous Liquid Drinking Water Solid Wipes	Spectrophotometry	EPA Method 7473 (SW-846)	Detection: Detection limit 0.01 ng (total mercury) Working Range: Working range 0.05 – 600 ng Sample Throughput: Analysis time <5 minutes Interferences: Inteferfences include memory effects from high concentration samples Other: Thermal decomposition, desorption, and atomic absorption
	Aqueous Liquid Drinking Water		Mercury Tracker 3000 IP Portable Mercury Vapor Detector http://www.mercury-instrumentsusa.com/TrackerIP.htm (accessed November 19, 2009)	Detection: Detection limit 0.1 µg/m^3; detection range 0.1 – 2000 µg/m^3
			Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.1 – 2.5 µg/L Sample Throughput: Method takes >2 hours Interferences: No known interferences Other: Cold vapor method
	Air	Nextteq Gastec® gas detection tube (fieldable)	Nextteq Gastec® gas detection tube Mercury Vapor (P/N 19026282) https://www1.fishersci.com/Coupon;jsessionid=EoYtTAmK7vdGN1Njc1v909NF0wtwNAeoJtfcJFfuD1Khfn5XdteN!-1343026010?cid=1342&gid=2444789&details=Y (accessed November 19, 2009)	Detection: Detection range 0.05 – 13.2 mg/m^3
Methyl acrylonitrile	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC	EPA Method 8316 (SW-846)	Detection: Detection limit 10 µg/L (acrylamide) and 20 µg/L (acrylonitrile)
	Air		OSHA Method PV2004	Detection: Detection limit 0.7 µg/mL (0.006 mg/m^3 for a 1-mL desorption volume or 0.029 mg/m^3 for a 5-mL desorption volume based on a 120-L air volume) Working Range: 0.017 – 1.5 mg/m^3 (1-mL desorption volume) and 0.083 – 7.5 mg/m^3 (5-mL desorption volume)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Methyl fluoroacetate (analyze for fluoroacetate ion)	Air Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limits 5 µg/L (water); 5 µg/kg (solid) Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.
		GC-MS or -ECD	Analytical Letters. 1997. 27(14): 2703–2718	Detection: Detection range 0.02 – 2.00 mg/L Sample Preparation: Solid and non-aqueous liquid/organic samples are extracted ultrasonically with water, then partitioned with hexane and acidified prior to re-extraction with ethyl acetate. Aqueous and drinking water samples are partitioned with hexane, and acidified prior to re-extraction with ethyl acetate. The ethyl acetate fraction is taken to dryness in the presence of TEA, and the resulting acid is derivatized with pentafluorobenzyl bromide.
	Air	GC-MSD	Modified EPA Method TO-10A or TO-17 (ORD)	Performance: For TO-10A RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption or extraction from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Methyl hydrazine	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Method 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique Quantitation: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Methyl hydrazine	Aqueous Liquid Drinking Water Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: Shake and shoot solvent extraction Other: Tested on similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	GC-MS (purge and trap)	EPA Method TO-15 (ORD)	Sample Preparation: Analyze from canisters using Method TO-15 and limited QC for rapid analysis
Methyl isocyanate	Air	HPLC fluorescence or UV	OSHA Method 54	Detection: Detection limit 0.072 µg/sample Sample Throughput: Retention time ~8 – 12 minutes Sample Preparation: Sorbent tube collection
Methyl paraoxon **Methyl parathion**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: $MeCl_2$ extraction Other: Tested on similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid	GC-MS-SPME	Journal of Chromatography A. 2002. 963: 107–116	Detection: Detection limit 0.09 µg/L (methyl parathion) Sample Throughput: Retention time ~31.26 minutes (methyl parathion)
	Air	GC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Methylamine	Air	Passive Sampler for Amines	UME^x 400 Passive Sampler for Amines http://www.skcinc.com/prod/500-400.asp (accessed November 19, 2009)	Detection: Detection range 0.5 – 10 ppm Performance: Recovery ±30% Other: Detection at 254 nm. Does distinguish between different amines.
		DraegerSensor®	DraegerSensor® XS Amine http://www.afcintl.com/pdf/draeger/6809545.pdf (accessed November 19, 2009)	Detection: Detection limit 50 ppm Other: Does not distinguish between different amines

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Methylamine	Air	Gas detection tube	Kitagawa Gas Detector Tube System http://www.itraders.biz/komyo/index.html (accessed November 19, 2009)	Detection: Detection limit 50 ppm Interferences: Interferences include PH_3, H_2S, NO, H_2, methanol, CO_2, Cl_2, and NO_2 Other: Does not distinguish between different amines
N-Methyldiethanolamine (MDEA) (degradation product of HN-2)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	LC-MS	Journal of Chromatography A. 2006. 1102: 214–223	Sample Preparation: Soils and non-aqueous liquid/organic solid should first be extracted into water Other: Qualitative screening procedure developed using LC-MS and eliminating the need for additional sample handling and derivatization typically required for GC-MS analysis. An LC with a mixed mode column and isocratic elution gave good chromatography.
	Air	HPLC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
1-Methylethyl ester ethyl-phosphonofluoridic acid (GE)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-ESI-MS-SIM	Journal of Chromatography. 1998. 794: 234–244	Detection: Detection limits are two times lower than for LC-APCI-MS-SIM Sample Throughput: Retention time ~5.1 minutes Sample Preparation: Water samples can be analyzed directly. Soil samples and non-aqueous liquid samples are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (an instrument blank and instrument tune, but no calibration standards)
	Air	HPLC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Methylphosphonic acid (MPA) (degradation product of VX, GB, & GD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-ESI-MS-SIM	Journal of Chromatography. 1998. 794: 234–244	Detection: Detection limits are two times lower than for LC-APCI-MS-SIM Sample Throughput: Retention time ~5.1 minutes Sample Preparation: Water samples can be analyzed directly. Soil samples and non-aqueous liquid/organic solid samples are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Methylphosphonic acid (MPA) (degradation product of VX, GB, & GD)	Air	HPLC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (an instrument blank and instrument tune, but no calibration standards)
Mevinphos	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: $MeCl_2$ extraction Other: Tested on similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	SPME sampling portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
Monocrotophos	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Method 5030C (water) or 5035A (solid) with 8260C (SW-846)	Working Range: Calibration range 1 – 100 mg/L Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples and Method 5035A for solid samples Interferences: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation. Tested for similar compounds.
	Air	Automated thermal desorption GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Samples can be analyzed only once Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Mustard, nitrogen (HN-1) [bis(2-chloroethyl) ethylamine] **Mustard, nitrogen (HN-2) [2,2'-dichloro-N-methyldiethylamineN,N-bis(2-chloroethyl) methylamine]** **Mustard, nitrogen (HN-3) [tris(2-chloroethyl) amine]**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Recovery range in water 2 – 4%; in soil 28 – 60% Sample Preparation: $MeCl_2$ extraction Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Aqueous Liquid	HPLC-ESI-MS	Journal of Chromatography A. 2006. 1102: 214–223	Other: Qualitative screening procedure developed using LC-MS and eliminating the need for additional sample handling and derivatization typically required for GC-MS analysis. An LC with a mixed mode column and isocratic elution gave good chromatography.
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
	Air	GC-MS	Journal of Chromatography A. 2006. 1102: 214–223	Detection: Detection limit 50 ng/tube (full scan). S:N ratio at 50 ng/tube was ≥4:1. Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Samples can be analyzed only once Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)
		GC-NPD	Journal of Chromatography A. 1999. 849: 529–540	Sample Preparation: GC-NPD configured for thermal desorption of a DAAMS tube Other: Tested for HN1 and HN3
Mustard, sulfur / Mustard gas (HD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	Portable GC-MS (fieldable)	Field Analytical Chemistry and Technology. 1998. 2(1): 3–20	Other: S:N for 0.7 ng injection (neat) 8.5
		GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Recovery in water 50%; in soil 72 – 98% Sample Preparation: $MeCl_2$ extraction Other: Tested for similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Mustard, sulfur / Mustard gas (HD)	Aqueous Liquid Solid Wipes	GC-MS-EI	EPA Methods 3571/3572 with 8271 (SW-846)	Performance: For direct injection soil recovery range (and RSD) for GB 99.6 – 145 (±12.3)%; HD 103 – 112 (±19)%); VX 61 – 110 (±6.9)%. For DAAMS soil recovery range (and RSD) for GB 78 – 95 (±7.2)%; HD 84 – 94 (±5.4)%; VX 71 – 85 (±6.9)%. For direct injection water recovery range (and RSD) for GB 103 – 135 (±5.7)%; HD 95 – 151 (±6)%; VX 95 – 151 (±17)%. Sample Preparation: Uses a solid sorbent (Chromosorb® 106 [GB]; Chromosorb® 106/AgF [VX] or Tenax® TA [HD]) for extract or standard concentration followed by thermal desorption into the analytical system Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		GC-FPD	EPA Methods 3571/3572 with 8170 (SW-846)	Performance: For direct injection soil recovery range (and RSD) for GB 88 – 104 (±5.7)%; HD 94 – 104 (±3.9)%); VX 92 – 114 (±8.2)%. For DAAMS soil recovery range (and RSD) for GB 96 – 128 (±9)%; HD 124 – 139 (±7)%; VX 85 – 107 (±8)%. For direct injection water recovery range (and RSD) for GB 77 – 90 (±5.7)%; HD 77 – 90 (±6)%; VX 87 – 103 (±5.7)%. Sample Preparation: Employs a solid sorbent [Chromosorb® 106 (GB); Chromosorb® 106/AgF (VX); or Tenax® TA (HD)] for extract or standard concentration followed by thermal desorption into the analytical system Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
	Air	Portable GC-MS (fieldable)	Sensors and Actuators B. 2005. 108: 193–197	Quantitation: Able to qualitatively and semi-quantitatively identify mustard Sample Throughput: Analyte identified within 12 minutes Interferences: High mustard concentrations lead to memory effects
		GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Detection: Detection limit 50 ng/tube (full scan). S:N at 50 ng/tube ≥4:1. Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Samples can be analyzed only once Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Nicotine compounds (analyze as nicotine)	Aqueous Liquid Drinking Water Solid Wipes	GC-MS	Journal of Chromatography A. 2003. 1017: 187–93	Sample Throughput: Retention time ~18.7 minutes Sample Preparation: Extract with ether and 10% sodium hydroxide solution
	Non-aqueous Liquid/Organic Solid		EPA Method 8270D (SW-846)	Sample Preparation: $MeCl_2$ extraction Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	Aqueous Liquid Drinking Water Solid Wipes	Rapid HPLC	Journal of Forensic Science. 2005. 49(6): 1181–1186	Detection: Detection of TNT at concentrations >1 ppm. 95% of samples containing <0.7 ppm of TNT will produce a negative result. Working Range: 1 – 30 ppm (TNT)
	Non-aqueous Liquid/Organic Solid Solid Wipes	Rapid TLC (fieldable)	Chemistry for the Protection of the Environment 4. 2003. 59: 125–135	Quantitation: Semi-quantitative
	Solid Wipes	Immunoassay	EPA Method 4050 (SW-846)	Detection: Detection limit >500 ppm Sample Preparation: Performed using an extract of a soil sample Other: Test designed to detect TNT
			EPA Method 4051 (SW-846)	Detection: Detection limit 150 ppb Other: Test designed to detect RDX
		Colorimetric screening	EPA Method 8510 (SW-846)	Interferences: Other chemically-related explosives (i.e., nitroguanidine, NG, PETN, and tetryl)
Organophosphate pesticides, NOS	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	EPA Method 8270D (SW-846)	Detection: Compound dependent, detection range between 10 – 1000 µg/L for aqueous liquid samples and 660 – 3300 µg/kg for soil samples Sample Preparation: $MeCl_2$ shake and shoot extraction Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Air	GC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Osmium tetroxide (analyze for osmium)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	Atomic absorption spectroscopy	Applied Spectroscopy. 1968. 22(5): 532–535	Detection: Sensitivity 1 ppm Quantitation: Relative error ±4% Working Range: Concentration range 1 – 300 ppm (total osmium) Sample Throughput: Operator time <5 minutes/sample Interferences: Results are not affected by the valence state of osmium
	Air (particulates) Solid	Portable X-ray fluorescence (fieldable)	EPA Method 6200 (SW-846)	Detection: MDL above the toxicity characteristic regulatory level for most RCRA analytes Sample Preparation: For air samples, use high-volume air samplers, and collect sample filters
Oxamyl	Aqueous Liquid Drinking Water	HPLC	Journal of Chromatography A. 1996. 726: 99–113	Detection: Detection limit 0.5 µg/L Performance: Recovery 21% Sample Throughput: Retention time ~11.88 minutes Other: Diode array with online sample enrichment
		HPLC-ESI-MS-SIM	Analytica Chimica Acta. 2004. 505: 209–215	Detection: Detection limit 0.10 µg/L Performance: Recovery 65% Sample Throughput: Retention time <3 minutes Sample Preparation: SPE
		MEKC	Electrophoresis. 2001. 22(11): 2260–2269	Working Range: 0.5 – 5.0 mg/L Sample Preparation: SPE and sample stacking. N-Methylcarbamates are extracted from aqueous samples with $MeCl_2$, and from soils, oily solid waste, and oils with acetonitrile. Interferences: Fluorescent compounds, primarily alkyl amines and compounds which yield primary alkyl amines on base hydrolysis, are potential sources of interferences Other: Developed for the determination of 14 pesticides such as aldicarb, carbofuran, isoproturon, chlorotoluron, metolachlor, mecoprop, dichlorprop, MCPA, 2,4-D, methoxychlor, TDE, DDT, dieldrin, and DDE in drinking water. Good recoveries of pesticides were obtained using SPE with sample pH adjusted to 2 – 3.
	Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-UV	EPA Method 8318A (SW-846)	Other: Tested for similar compounds (aldicarb and carbofuran)
	Air		NIOSH Method 5601	Detection: Detection limit 0.0025 µg/L Working Range: 0.05 – 1 µg/L

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Paraquat	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	Immuoassay (fieldable)	Envirologix Quantiplate Kit EP 023 www.envirologix.com (accessed November 19, 2009)	Detection: Detection limit 0.10 µg/L Working Range: 0.02 – 1.0 ppb Sample Throughput: Results in 90 minutes Other: Antibody-coated microwell plate; eight removable strips of 12 microwells each, in reclosable foil bag with desiccant
			SDI RAPID Assay® http://www.sdix.com/ProductSpecs.asp?nProductID=26 (accessed November 19, 2009)	Detection: Detection limit 20 ppt Sample Preparation: The Paraquat RAPID Assay® applies the principles of ELISA for the determination of free paraquat cation
		HPLC-MS	"Rapid Screening Method for the Analysis of Paraquat and Diquat by LC-MSD Using Selective Ion Monitoring and Large Volume Injection," Agilent Application Note, 2002 http://www.chem.agilent.com/Library/applications/5988-7220EN.pdf (accessed November 19, 2009)	Detection: Detection limit <0.4 µg/L Sample Preparation: Uses an ion-pairing reagent to help separate compounds and prepare paraquat in ionic form Sample Throughput: ~20 minutes per sample
Paraoxon **Parathion**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: $MeCl_2$ extraction Other: Tested on similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid	GC-MS-SPME	Journal of Chromatography A. 2002. 963: 107–116	Detection: Detection limit 0.09 µg/L (methyl parathion) Sample Throughput: Retention time ~31.26 minutes (methyl parathion)
	Air	GC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Pentaerythritol tetranitrate (PETN)	Aqueous Liquid Drinking Water Solid Wipes	Rapid HPLC	Journal of Forensic Science. 2005. 49(6): 1181–1186	Quantitation: Semi-quantitative Sample Throughput: Using HPLC with reversed-phase monolithic columns, 11 explosives can be quantified in <14 minutes. A rapid version of this technique can separate seven explosives in <2 minutes. Other: 2,6-DNT is not resolved from other DNT isomers. Procedure is based on a method for soil analyses, but could be modifed to analyze water matrices.
	Non-aqueous Liquid/Organic Solid Solid Wipes		Chemistry for the Protection of the Environment 4. 2003. 59: 125–135	–
Phencyclidine	Aqueous Liquid Drinking Water Solid Wipes	Immunoassay (fieldable)	Phencyclidine RapiCard™ Test http://www.rapidtest.com (accessed November 19, 2009)	Detection: Detection limit 25 µg/L Sample Preparation: Soil samples should be extracted in water Other: Phencyclidine RapiCard™ Test specifically designed for urine, but may work for water and soil analysis
		GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: MeCl$_2$ extraction Other: Tested for MeCl$_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air		EPA Method TO-13A (ORD)	Other: Air samples collected onto SUMMA canister for analysis by GC-MS. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
Phenol	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: MeCl$_2$ extraction Other: Tested for MeCl$_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
			EPA Methods 3520C/3535A (water), 3545A/3541 (solid), or 3580A (non-aqueous) with 8270D (SW-846)	Quantitation: Quantitation limit 10 µg/L (water); 660 µg/L (solid) Performance: Average recovery (n=4 with test concentration of 100 µg/L) 16.6 – 100.0% Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Phenol	Air	SPME sampling portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
		Draeger gas detection tube	Draeger gas detection tube Phenol 1/b (P/N 8101641) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection range 1 – 20 ppm Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
		GC-FID (direct injection)	EPA Method TO-8 (ORD)	Other: Aqueous impinger collection. Glass impingers may be fragile and thus may be easily broken.
		GC-MS or HPLC	EPA TO-10A (ORD)	Detection: Detection limits 0.2 – 10 µg/mL (HPLC) Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Phorate **Phorate sulfone** **Phorate sulfoxide**	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	GC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Phosgene	Air	GC-NPD	OSHA Method 61	Sample Preparation: Collect air samples on sorbent tubes for derivatization by 2-(hydroxymethyl)piperidine
		Draeger gas detection tube	Draeger gas detection tube Phosgene 0.02/a (P/N 8101521) http://www.afcintl.com/pdf/draeger/8101521.pdf (accessed November 19, 2009)	Detection: Detection ranges 0.02 – 1 ppm; 0.02 – 0.6 ppm Performance: Standard deviation ±10 – 15% Sample Throughput: ~12 minutes/sample Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent) Interferences: Chlorine and hydrochloric acid. Absolute humidity over 3 – 15 mg H_2O/L.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Phosphamidon	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Preparation: MeCl$_2$ extraction Other: Tested on similar compounds. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid	GC-MS-SPME	Journal of Chromatography A. 2002. 963: 107–116	Detection: Detection limit 0.09 µg/L (methyl parathion) Sample Throughput: Retention time ~31.26 minutes (methyl parathion)
	Air	GC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Phosphine	Air	Draeger gas detection tube (fieldable)	Draeger gas detection tube Phosphine 0.01/a (P/N 8101611); 0.1/a (P/N CH31101); 1/a (P/N 8101801); 25/a (P/N 8101621); 50/a (P/N CH21201) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection ranges 0.01 – 1 ppm; 0.1 – 4 ppm; 1 – 100 ppm; 25 – 10,000 ppm; 15 – 1,000 ppm; 0.01 – 100 ppm Sample Throughput: Measuring time 20 seconds – 13 minutes (depending on concentration) Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
		ICP-AES	OSHA Method 1003	Sample Preparation: Samples are collected by drawing air, with personal sampling pumps, through sampling cassettes containing a glass fiber filter and a mercuric chloride-treated polyester filter. Samples are digested with sulfuric acid and analyzed.
Phosphorus trichloride	Air	Spectrophotometer	NIOSH Method 6402	Sample Preparation: Samples are collected in bubbler for analysis by spectrophotometer
Pinacolyl methyl phosphonic acid (PMPA) (degradation product of GD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-ESI-MS-SIM	Journal of Chromatography. 1998. 794: 234–244	Sample Throughput: Retention time ~3.1 minutes Sample Preparation: Water samples can be analyzed directly. Soil and non-aqueous liquid samples are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		HPLC-APCI-MS-SIM	Journal of Chromatography A. 1999. 862(2): 169–177	Detection: Detection limits are two times lower than for LC-APCI-MS-SIM method Sample Throughput: Retention time ~3.1 minutes Sample Preparation: Water samples can be analyzed directly. Soil samples are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Pinacolyl methyl phosphonic acid (PMPA) (degradation product of GD)	Air	HPLC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: No derivatization required. Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
Propylene oxide	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	Detection: 1 – 2 µL injection of a 1:1 dilution can be used to provide detection limits of 0.5 ppm Sample Preparation: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Air	GC-MS	NIOSH Method 1612	Detection: Estimated 0.01 mg per sample Working Range: Working range 8 – 295 ppm for air samples of 5 L Sample Preparation: Thermal desorption from charcoal sorbent tube Other: Limited QC for rapid analysis
R-33 (VR) [Methylphosphonothioic acid, S-[2-(diethylamino)ethyl] O-2-methylpropyl ester]	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Average recovery for VX 52 – 59% (water); 59 – 68% (soil, using MeOH with 1% TEA) Sample Throughput: Samples can be analyzed only once Sample Preparation: MeCl$_2$ extraction (aqueous and solid samples). VX may require MeOH with 1% TEA for extraction from solids. Other: Tested for similar compound (VX) in water only. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs were generally <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds (G-agents and mustards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Sarin (GB)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Recovery for GB 69 – 80% (water); 62 – 114% (soil) Sample Throughput: Samples can be analyzed only once Sample Preparation: Shake and shoot MeCl$_2$ extraction Other: Tested for MeCl$_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water Solid Wipes	GC-FPD	EPA Methods 3571/3572 with 8170 (SW-846)	Performance: For direct injection soil recovery range (and RSD) for GB 88 – 104 (±5.7)%; HD 94 – 104 (±3.9)%); VX 92 – 114 (±8.2)%. For DAAMS soil recovery range (and RSD) for GB 96 – 128 (±9)%; HD 124 – 139 (±7)%; VX 85 – 107 (±8)%. For direct injection water recovery range (and RSD) for GB 77 – 90 (±5.7)%; HD 77 – 90 (±6)%; VX 87 – 103 (±5.7)%. Sample Preparation: Uses a solid sorbent [Chromosorb® 106 (GB); Chromosorb® 106/AgF (VX); or Tenax® TA (HD)] for extract or standard concentration followed by thermal desorption into the analytical system. Sample collection, preparation, preservation, and storage are described in Methods 3571 and 3572. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		GC-MS-EI	EPA Methods 3571/3572 with 8271 (SW-846)	Performance: For direct injection soil recovery range (and RSD) for GB 99.6 – 145 (±12.3)%; HD 103 – 112 (±19)%); VX 61 – 110 (±6.9)%. For DAAMS soil recovery range (and RSD) for GB 78 – 95 (±7.2)%; HD 84 – 94 (±5.4)%; VX 71 – 85 (±6.9)%. For direct injection water recovery range (and RSD) for GB 103 – 135 (±5.7)%; HD 95 – 151 (±6)%; VX 95 – 151 (±17)%. Sample Preparation: Uses a solid sorbent [Chromosorb® 106 (GB); Chromosorb® 106/AgF (VX); or Tenax® TA (HD)] for extract or standard concentration followed by thermal desorption into the analytical system. Sample collection, preparation, preservation, and storage are described in Methods 3571 and 3572. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested on a similar compound (GB). No sample preparation required.
	Drinking Water	GC-MS (fieldable)	Field Analytical Chemistry and Technology. 1998. 2(1): 3–20	Detection: S:N for injection of 0.6 ng (neat) 8.5

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Sarin (GB)	Air	GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
		Automated Thermal Desorption GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Detection: Detection limit 50 ng/tube (full scan). S:N ratio at 50 ng/tube was ≥4:1. Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Retention time ~8.3 minutes. Samples can be analyzed only once. Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)
Semivolatile organic compounds, NOS	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: MeCl$_2$ extraction Other: Tested for MeCl$_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Air	GC-MSD	Modified EPA Method TO-10A or TO-17 (ORD)	Performance: RSD range 5 – 30% (n>5). Recoveries ranging from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Sodium arsenite (analyze for total arsenic)	Air (particulates) Solid Wipes	X-ray fluorescence analyzer (fieldable)	EPA Method 6200 (SW-846)	Detection: Interference-free detection limit 40 mg/kg Interferences: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Detection range 0.02 – 0.20 mg/L. Measures total arsenic Interferences: Potential interferences include antimony salts Other: Silver diethyldithio-carbamate method

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Sodium arsenite (analyze for total arsenic)	Aqueous Liquid Drinking Water	ICP-AES or -MS	EPA Method 6010C (SW-846); EPA Methods 200.7/200.8 (OW)	<u>Detection</u>: Estimated detection limit 53 µg/L (Method 200.7). Method detection limit 1.4 µg/L (water); 0.6 µg/L (solids) (for Method 200.8). <u>Sample Preparation</u>: Acid-digestion, filtration. Add HNO_3 and evaporate to near dryness then reflux. Continue heating and add additional acid as necessary, until the digestion is complete (Method 200.7). Groundwater samples which have been prefiltered and acidified will not need acid digestion (Method 6010C). <u>Interferences</u>: Background contribution from emission of high concentration elements, >100 mg/L of aluminum, dust in the laboratory environment, impurities in reagents, and on laboratory apparatus which the sample contacts (Method 200.7) <u>Other</u>: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
	Non-aqueous Liquid/Organic Solid	ICP-MS	EPA Method 6020A (SW-846)	<u>Sample Preparation</u>: Extraction in aqueous nitric acid <u>Other</u>: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
	Air	ICP-AES	EPA Method 200.7 (OW)	<u>Sample Throughput</u>: A significant amount of time is saved by digesting air samples in plastic centrifuge tubes using microwave energy at atmospheric pressure <u>Other</u>: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES
Sodium azide (analyze as azide ion)	Air Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid) or 3585 (non-aqueous) with 8260C (SW-846)	<u>Detection</u>: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique <u>Quantitation</u>: Quantitation limits 5 µg/L (water); 5 µg/kg (solid) <u>Sample Preparation</u>: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid/organic solid samples <u>Interferences</u>: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.
	Aqueous Liquid Drinking Water Solid Wipes	IC	J. of Forensic Sciences. 1998. 43(1): 200–202	<u>Detection</u>: Detection limit 30 ng/mL <u>Performance</u>: Recovery range 83 – 85% <u>Working Range</u>: Calibration range 100 – 10,000 ng/mL <u>Sample Preparation</u>: Acidification to NH_3 (gas) and bubbled through NaOH

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Sodium azide (analyze as azide ion)	Air Wipes	IC	OSHA Method ID-211	<u>Detection</u>: Detection limit (for 5-L air sample) 0.001 ppm (0.003 mg/m^3) <u>Quantitation</u>: Quantitation limit 0.004 ppm (0.011 mg/m^3) <u>Working Range</u>: 0.057 – 2.63 ppm <u>Interferences</u>: Ions such as bromides, adipic acid, or nitrates. Do not use wipe materials composed of cellulose (PVC or glass fiber wipes recomended).
Soman (GD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	<u>Performance</u>: Recovery for GD 84 (±9)% (water); 85 – 99% (soil) <u>Sample Throughput</u>: Samples can be analyzed only once <u>Sample Preparation</u>: MeCl$_2$ extraction <u>Other</u>: Tested for MeCl$_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	<u>Detection</u>: Method detection range 0.07 – 0.7 mg/L <u>Performance</u>: RSDs <10% <u>Sample Throughput</u>: Sample cycle time 45 seconds <u>Sample Preparation</u>: Direct sampling in water <u>Other</u>: Tested for similar compounds
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	<u>Sample Throughput</u>: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. <u>Sample Preparation</u>: SPME sampling and thermal desorption <u>Interferences</u>: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. <u>Other</u>: Tested for similar compounds
Strychnine	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Based on results of Battelle evaluation (2006) of analytical procedures for detection of strychnine	<u>Sample Preparation</u>: Base extraction
			Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	<u>Sample Throughput</u>: Samples can be analyzed only once <u>Sample Preparation</u>: MeCl$_2$ extraction <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Solid Wipes	HPLC-MS	EPA Method 8321B (SW-846)	<u>Sample Preparation</u>: Acetonitrile/water extraction <u>Interferences</u>: Compounds with high proton affinity may mask target analytes <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Sulfur dioxide	Air	UV luminescence detector	Environmental Field Technologies Verification Program http://www.epa.gov/etv/vt-ams.html#hsm (accessed November 19, 2009)	Detection: Detection range 4 – 300 ppb Performance: Recovery 131% Interferences: Interferences include carbanyl sulfide, dimethyl sufide, and methyl mercaptan
		Toxic Gas leak detector	CEA S-3200 Toxic Gas Leak Detector http://www.ceainstr.com/pdf_datasheets/seriesu_Info.pdf (accessed November 19, 2009)	Detection: Detection ranges 0 – 250 ppm; 0 – 1000 ppm; 0 – 10,000 ppm
		Draeger gas detection tube	Draeger gas detection tube Sulfur Dioxide 0.1/a (P/N 6727101); 0.5/a (P/N 6728491); 1/a (P/N CH31701); 20/a (P/N CH24201); 50/b (P/N 8101531) http://www.draeger.com/US/en_US/ (accessed November 19, 2009)	Detection: Detection ranges 0.1 – 3 ppm; 0.5 – 25 ppm; 1 – 25 ppm; 20 – 20,000 ppm; 50 – 8,000 ppm Sample Preparation: A calibrated 100-mL sample of air is drawn through the tube with a pump (Draeger accuro® or equivalent)
Sulfur trioxide	Air	Titrimetry	EPA Method 8 (OAQPS)	Detection: Detection limit 0.06 mg/m^3 (as H_2SO_4)
Tabun (GA)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Average recovery for GA 51 – 66% (water); 66 – 115% (soil) Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	GC-MS (portable) (fieldable)	Field Analytical Chemistry and Technology. 1998. 2(1): 3–20	Other: S:N ratio for injection of 1.5 ng (neat) 5.9
	Aqueous Liquid	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Tabun (GA)	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
		GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Detection: Detection limit 50 ng/tube (full scan). S:N ratio at 50 ng/tube was ≥4:1. Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Retention time ~8.3 minutes. Samples can be analyzed only once. Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries being observed after one day of storage in a freezer (-12°C)
Tetraethyl pyrophosphate	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction (aqueous and solid samples) Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
Tetramethylene-disulfotetramine	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction (aqueous and solid samples) Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
		SPME-GC-NPD	Analytica Chimica Acta. 2000. 404(2): 329–334	Detection: Detection limit 0.001 mg/mL Working Range: Concentration range 0.008 – 0.5 mg/mL (with correlation coefficient of 0.998) Sample Preparation: Tetramine was extracted with a fused silica fiber coated with 100-mm PDMS and detected by GC with a NPD
	Air	GC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5). Recoveries ranging from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Thallium sulfate (analyze for total thallium)	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Interferences: Potential interferences include antimony salts; measures total arsenic Other: Silver diethyldithio-carbamate method
		ICP-AES or -MS	EPA Method 6010C (SW-846); EPA Methods 200.7/200.8 (OW)	Sample Preparation: Acid-digestion, filtration. Add HNO_3 and evaporate to near dryness then reflux. Continue heating and add additional acid as necessary, until the digestion is complete (Method 200.7). Groundwater samples which have been prefiltered and acidified will not need acid digestion (Method 6010C). Interferences: Background contribution from emission of high concentration elements, >100 mg/L of aluminum, dust in the laboratory environment, impurities in reagents, and on laboratory apparatus which the sample contacts (Method 200.7) Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
	Non-aqueous Liquid/Organic Solid	ICP-MS	EPA Method 6020A (SW-846)	Sample Preparation: Extraction in aqueous nitric acid Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
	Air (particulates) Solid Wipes	X-ray fluorescence analyzer (fieldable)	EPA Method 6200 (SW-846)	Interferences: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals.
	Air	ICP-AES	EPA Method 200.7 (OW)	Sample Throughput: A significant amount of time is saved by digesting air samples in plastic centrifuge tubes using microwave energy at atmospheric pressure Other: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES
Thiodiglycol (TDG) (degradation product of HD)	Aqueous Liquid Drinking Water Solid	HPLC-APCI-MS-SIM	Journal of Chromatography A. 1999. 862(2): 169–177	Detection: Detection limit ≤10 ng/mL (in water, using 20 µL injections) Sample Throughput: Retention time ~5.2 minutes Sample Preparation: Water samples can be analyzed directly. Soil samples are extracted with water, filtered, and analyzed. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
	Aqueous Liquid Drinking Water	ESI-MS-SRM	Rapid Communications in Mass Spectrometry. 2006. 20: 981–986	Detection: Detection limit 500 µg/L (with 10 µL injection). For low concentrations, the addition of ammonium halides is required to see the [M-H]- peak. Sample Preparation: Water samples can be analyzed directly. Does not require any sample preparation.
	Air	GC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5). Recoveries ranging from 65 – 125%. Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Thiofanox	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	HPLC-UV	Chemosphere. 2005. 61: 1580–1586	Sample Preparation: Filtration, requires no extraction Other: Tested for similar compounds
		HPLC-APCI-MS-SPE	"A General Unknown Screening For Drugs and Toxic Compounds in Human Serum." Thesis. http://pages.unibas.ch/diss/2005/DissB_7295.pdf (accessed November 19, 2009)	Sample Preparation: SPE cartridge extraction Other: Tested for similar compounds
		HPLC-APCI-MS-LLE	Journal of Chromatography B. 1999. 731: 155–165	Sample Preparation: Extraction with ethyl acetate and evaporation to dryness, followed by redissolving in acetonitrile Other: Tested for similar compounds
	Air	HPLC-UV	NIOSH Method 5601	Sample Preparation: Collect air samples on sorbents. Extraction (with 0.2% V/V 0.1 M aqueous triethylamine phosphate buffer in acetonitrile, pH 6.9 – 7.1) from filter/solid sorbent tube (OVS-2 Tube: 13-mm quartz fiber filter; XAD-2, 270 mg/140 mg). Interferences: Potential interferences include chloroform, toluene, BHT, dialkyl phthalates, nicotine, caffeine, impurities in HPLC reagents (e.g., in triethylamine), other pesticides (2,4-D, atrazine, parathion, etc.), and pesticide hydrolysis products (1-naphthol) Other: Tested for similar compounds
1,4-Thioxane (degradation product of HD)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (fieldable)	Field Analytical Chemistry and Technology. 1998. 2(1): 3–20	Other: S:N for injection of 3.1 ng (neat) 17.3
		GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Titanium tetrachloride (analyze for total titanium)	Solid Wipes	ICP-AES	EPA Method 6010C (SW-846); EPA Method 200.7 (OW)	Detection: Estimated instrument detection limit 5 µg/L (for Method 6010C, as titanium at 334.9 nm) Sample Preparation: Acid-digestion, filtration. Add HNO_3 and evaporate to near dryness then reflux. Continue heating and add additional acid as necessary, until the digestion is complete (Method 200.7). Groundwater samples which have been prefiltered and acidified will not need acid digestion (Method 6010C). Interferences: Background contribution from emission of high concentration elements, >100 mg/L of aluminum, dust in the laboratory environment, impurities in reagents and on laboratory apparatus Other: Use limited QC for rapid analysis (e.g., an instrument blank and an instrument tune, but no standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
		Portable X-ray fluorescence (fieldable)	EPA Method 6200 (SW-846)	Detection: MDL above the toxicity characteristic regulatory level for most RCRA analytes
		ICP-MS	EPA Method 6020A (SW-846); EPA Method 200.8 (OW)	Sample Preparation: Acid-digestion and filtration Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
Triethanolamine (TEA) (degradation product of HN-3)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	LC-MS	Journal of Chromatography A. 2006. 1102: 214–223	Detection: Detection limit 0.02 ppm Sample Throughput: Analysis time <20 minutes Sample Preparation: Soils and non-aqueous liquid/organic solids should first be extracted into water. Acetonitrile (1 mL) is added to emulsion and vortexed for 10 seconds followed by centrifugation at 4500g for 10 minutes. Water samples are analyzed directly.
	Air	HPLC-MS	EPA Method TO-10A (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
Trimethyl phosphite	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction Other: Tested for $MeCl_2$, GB, GD, HD, and GF at concentrations of 5.0 mg/m^3. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Trimethyl phosphite	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
1,3,5-Trinitrobenzene (1,3,5-TNB)	Aqueous Liquid Drinking Water Solid Wipes	Rapid HPLC	Journal of Forensic Science. 2005. 49(6): 1181–1186	Sample Throughput: A rapid version of this technique can separate seven explosives in <2 minutes Other: Has been evaluated for similar compounds. TNT cannot be resolved from tetryl. This procedure is based on a method for soil analyses but could be modifed to analyze water matrices.
	Non-aqueous Liquid/Organic Solid Solid Wipes	Rapid TLC (fieldable)	Chemistry for the Protection of the Environment 4. 2003. 59: 125–135	Quantitation: Semi-quantitative
	Solid Wipes	Immunoassay	EPA Method 4050 (SW-846)	Detection: Detection limit 4 ppm
2,4,6-Trinitrotoluene (2,4,6-TNT)	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	Rapid HPLC	Journal of Forensic Science. 2005. 49(6): 1181–1186	Sample Throughput: A rapid version of this technique can separate seven explosives in <2 minutes Other: Has been evaluated for similar compounds. TNT cannot be resolved from tetryl. This procedure is based on a method for soil analyses but could be modifed to analyze water matrices.
	Non-aqueous Liquid/Organic Solid Solid Wipes	Fast GC-PDECD or -MS	Journal of Forensic Science. 2006. 51: 815	Sample Throughput: Nine explosives detected in <3 minutes Sample Preparation: No sample preparation method was investigated; Method 8330 is recommended for solids and Method 3535 is recommended for liquids

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
2,4,6-Trinitrotoluene (2,4,6-TNT)	Solid Wipes	Immunoassay	EPA Method 4050 (SW-846)	Detection: Detection limit 0.5 ppm Performance: Using the test kit from which this method was developed, 93% of soil samples containing ≤0.25 ppm of 2,4,6-TNT will produce a negative result, and 99+% of soil samples containing ≥1.0 ppm of 2,4,6-TNT will produce a positive result
	Solid Wipes	Colorimetric screening	EPA Method 8515 (SW-846)	Detection: Detection of TNT at concentrations >1 ppm. 95% of samples containing ≤0.7 ppm of TNT will produce a negative result. Working Range: 1 – 30 ppm (TNT) Sample Preparation: Sample is treated with color-change reagents and read in spectrophotometer Performance: Average recovery for 5 ppm spike (n=22) 5.1 (±0.4) ppm with 7.8% RSD
Vanadium pentoxide (analyze for total vanadium)	Air (particulates) Solid Wipes	X-ray fluorescence analyzer (fieldable)	EPA Method 6200 (SW-846)	Interferences: Potential interferences include particle size, uniformity, homogeneity, surface condition, high moisture content, and high concentration of other heavy metals
	Aqueous Liquid Drinking Water	Spectrophotometry	Hach Water Analysis Handbook. 5th Edition. 2008	Detection: Measures total arsenic Interferences: Potential interferences include antimony salts Other: Silver diethyldithio-carbamate method
		ICP-AES or -MS	EPA Method 6010C (SW-846); EPA Methods 200.7/200.8 (OW)	Sample Preparation: Acid-digestion, filtration. Add HNO_3 and evaporate to near dryness then reflux. Continue heating and add additional acid as necessary, until the digestion is complete (Method 200.7). Groundwater samples which have been prefiltered and acidified will not need acid digestion (Method 6010C). Interferences: Background contribution from emission of high concentration elements, >100 mg/L of aluminum, dust in the laboratory environment, impurities in reagents, and on laboratory apparatus which the sample contacts (Method 200.7) Other: Use limited QC for rapid analysis (e.g., a blank and an instrument tune, but no standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
	Non-aqueous Liquid/Organic Solid	ICP-MS	EPA Method 6020A (SW-846)	Sample Preparation: Extraction in aqueous nitric acid Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES.
	Air	ICP-AES	EPA Method 200.7 (OW)	Sample Throughput: A significant amount of time is saved by digesting air samples in plastic centrifuge tubes using microwave energy at atmospheric pressure Other: In cases where low concentrations of compounds are being addressed, ICP-MS instrumentation may be more appropriate than ICP-AES

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
VE [phosphonothioic acid, ethyl-, S-(2-(diethylamino)ethyl) O-ethyl ester]	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Average recovery for VX 52 – 59% (water); 59 – 68% (soil, using MeOH with 1% TEA) Sample Throughput: Samples can be analyzed only once Sample Preparation: $MeCl_2$ extraction (aqueous and solid samples). VX may require MeOH with 1% TEA for extraction from solids. Other: Tested for similar compound (VX) in water only. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs were generally <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
VG [phosphonothioic acid, S-(2-diethylamino)ethyl)O,O-diethyl ester]	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Average recovery for VX 52 – 59% (water); 59 – 68% (soil, using MeOH with 1% TEA) Sample Throughput: Samples can be analyzed once Sample Preparation: $MeCl_2$ extraction (aqueous and solid samples). VX may require MeOH with 1% TEA for extraction from solids. Other: Tested for VX in water. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
VG [phosphonothioic acid, S-(2-diethylamino)ethyl)O,O-diethyl ester]	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	<u>Sample Throughput</u>: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. <u>Sample Preparation</u>: SPME sampling and thermal desorption <u>Interferences</u>: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system.
VM [phosphonothioic acid, methyl-,S-(2-diethylamino)ethyl) O-ethyl ester]	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	<u>Performance</u>: Average recovery for VX 52 – 59% (water); 59 – 68% (soil, using MeOH with 1% TEA) <u>Sample Throughput</u>: Samples can be analyzed only once <u>Sample Preparation</u>: $MeCl_2$ extraction (aqueous and solid samples). VX may require MeOH with 1% TEA for extraction from solids. <u>Other</u>: Tested for VX in water. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	<u>Detection</u>: Method detection range 0.07 – 0.7 mg/L <u>Performance</u>: RSDs were generally <10% <u>Sample Throughput</u>: Sample cycle time 45 seconds <u>Sample Preparation</u>: Direct sampling in water <u>Other</u>: Tested for similar compounds
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	<u>Sample Throughput</u>: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. <u>Sample Preparation</u>: SPME sampling and thermal desorption <u>Interferences</u>: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system.
Volatile Organic Compounds, NOS	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS (purge and trap)	EPA Methods 5030C (water), 5035A (solid), or 3585 (non-aqueous) with 8260C (SW-846)	<u>Detection</u>: Detection limits 5 µg/kg (wet weight) for soil/sediment samples; 0.5 mg/kg (wet weight) for wastes; 5 µg/L for ground water, using standard quadrupole instrumentation and the purge and trap technique <u>Quantitation</u>: Quantitation limit 5 µg/L (water); 5 µg/kg (solid) <u>Working Range</u>: Calibration range 1 – 100 mg/L <u>Sample Preparation</u>: Based on Method 8260 using Method 5030C for preparation of water samples, Method 5035A for solid samples, and Method 3585 for non-aqueous liquid samples <u>Interferences</u>: Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap <u>Other</u>: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards). May require low injection port temperatures due to thermal degradation.

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
Volatile Organic Compounds, NOS	Air	GC-MSD	Modified EPA Method TO-10A or TO-17 (ORD)	Performance: RSD range 5 – 30% (n>5); recoveries range from 65 – 125% Sample Preparation: Thermal desorption from XAD with Tenax® tube Other: Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		GC-FID or -ECD	EPA Method TO-3 (ORD)	Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		SUMMA canister	EPA Method TO-1 (ORD)	Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
VX [O-ethyl-S-(2-diisopropylaminoethyl) methyl phosphonothiolate]	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds
		GC-MS	Sample Preparation Method for GC/MS Analysis On Site Joint Document: United States/Finland. 1997. 1: 1–125	Performance: Average recovery for VX 52 – 59% (water); 59 – 68% (soil, using MeOH with 1% TEA) Sample Throughput: Samples can be analyzed only once Sample Preparation: MeCl extraction (aqueous and solid samples). VX may require MeOH with 1% TEA for extraction from solids. Other: Tested for similar compound VX in water only. Full scan using limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards).
	Aqueous Liquid Drinking Water	Photoionization mass spectrometry	Analytical Chemistry. 2006. 78: 2967–2976	Detection: Method detection range 0.07 – 0.7 mg/L Performance: RSDs <10% Sample Throughput: Sample cycle time 45 seconds Sample Preparation: Direct sampling in water Other: Tested for similar compounds
	Air	Portable GC-MS (fieldable)	TrAC — Trends in Analytical Chemistry. 2004. 23(4): 296–306	Sample Throughput: Analysis time ~16 minutes; total sample throughput ~3 samples/hour. Retention time for GB ~6 minutes; phenol ~11 minutes; GD ~12 minutes; HD ~13 minutes; GF ~14 minutes. Sample Preparation: SPME sampling and thermal desorption Interferences: GF and HD resolution were poor and required spectral manipulation for library matching (i.e., subtraction of interfering compound spectrum). Soman diastereomers could not be distinguished with this system. Other: Tested for similar compounds

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
VX [O-ethyl-S-(2-diisopropylaminoethyl) methyl phosphonothiolate]	Air	GC-MS	Journal of Chromatography A. 2001. 925: 241–249	Detection: Detection limit 50 ng/tube (full scan). S:N ratio at 50 ng/tube was ≥4:1. Quantitation: Semi-quantitative Performance: RSD at 50 ng/tube for GB 21%; GD1 17%; GD2 13%; GA 8%; GF 11%; VX 30%; HN1 22%; HN2 28%; HN3 17% Sample Throughput: Retention time ~12 minutes. Samples can be analyzed only once. Sample Preparation: Automated thermal desorption. Tube is connected to heated GC injector (100°C). Other: Temperature and time of storage were found to influence recovery of analytes, with best recoveries observed after one day of storage in a freezer (-12°C)
	Aqueous Liquid Solid Wipes	GC-MS-EI	EPA Methods 3571/3572 with 8271 (SW-846)	Performance: For direct injection soil recovery range (and RSD) for GB 99.6 – 145 (±12.3)%; HD 103 – 112 (±19)%); VX 61 – 110 (±6.9)%. For DAAMS soil recovery range (and RSD) for GB 78 – 95 (±7.2)%; HD 84 – 94 (±5.4)%; VX 71 – 85 (±6.9)%. For direct injection water recovery range (and RSD) for GB 103 – 135 (±5.7)%; HD 95 – 151 (±6)%; VX 95 – 151 (±17)%. Sample Preparation: Employs a solid sorbent [Chromosorb® 106 (GB); Chromosorb® 106/AgF (VX); or Tenax® TA (HD)] for extract or standard concentration followed by thermal desorption into the analytical system. Sample collection, preparation, preservation, and storage are described in Methods 3571 and 3572. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)
		GC-FPD	EPA Methods 3571/3571 with 8170 (SW-846)	Performance: For direct injection soil recovery range (and RSD) for GB 88 – 104 (±5.7)%; HD 94 – 104 (±3.9)%); VX 92 – 114 (±8.2)%. For DAAMS soil recovery range (and RSD) for GB 96 – 128 (±9)%; HD 124 – 139 (±7)%; VX 85 – 107 (±8)%. For direct injection water recovery range (and RSD) for GB 77 – 90 (±5.7)%; HD 77 – 90 (±6)%; VX 87 – 103 (±5.7)%. Sample Preparation: Employs a solid sorbent [Chromosorb® 106 (GB); Chromosorb® 106/AgF (VX); or Tenax® TA (HD)] for extract or standard concentration followed by thermal desorption into the analytical system. Sample collection, preparation, preservation, and storage are described in Methods 3571 and 3572. Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

Table 1: Rapid Screening and Preliminary Identification Techniques and Methods for the Chemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source*	Comments
White phosphorus	Aqueous Liquid Drinking Water Non-aqueous Liquid/Organic Solid Solid Wipes	GC-MS	Based on EPA Method 7580 (SW-846) using an MS detector	Detection: Two different extraction procedures for water with sensitivities on the order of 0.01 µg/L and 0.1 µg/L. Soil extraction procedure provides sensitivity on the order of 1 µg/kg. Performance: Mean recovery 30 – 130% Sample Preparation: Shake and shoot isooctane or ether extraction. Solid samples may require extraction for up to 18 hours prior to analysis. Other: Method has been evaluated for this compound using an NPD detector
	Air	GC-FPD	NIOSH Method 7905	Detection: 0.005 µg per sample Quantitation: 0.5 – 5 µg per sample Working Range: 0.04 – 0.8 mg/m^3 (0.0008 – 0.16 ppm) for a 12-L air sample Performance: Average recovery ~106% (n=18); 0.056 – 0.24 mg/m^3 for 12-L samples Sample Preparation: Extraction from sorbent tube with xylene Other: Limited QC for rapid analysis (e.g., an instrument blank and instrument tune, but no calibration standards)

*SAM methods listed in this column can be located using the U.S. Environmental Protection Agency, National Homeland Security Research Center's (NHSRC), *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events* (www.epa.gov/sam). SAM is intended to be used concurrently with this Rapid Screening and Preliminary Identification Techniques and Methods document. Full citations for references not accessible through SAM are provided in Section 3.0 of this document.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM

Note: When available, information is provided for emission energies, expected identifiable concentration (with 20% efficiency p-type), sample preparation, and analysis time (see Comments column).

Analyte	Matrix	Technique	Reference Source *	Comments
Gamma Emitters				
Gamma Emitters, General	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: 50 – 2000 keV; refer to selected gamma-emitting radionuclides for isotope-specific emission energies Expected Identifiable Concentration (with 20% efficiency p-type): See specific gamma-emitting radionuclides for expected identifiable concentrations. Note**:** Identifiable concentrations in samples may vary from these published values due to spectroscopy peak interferences from mixed radionuclides (if present) in the sample, spectroscopy summing effects, sample volumes, and counting times. Sample Preparation: Depending on the sample matrix, pretreatment (e.g., grinding, sieving) may be necessary to obtain a homogeneous sample. As much as is practical, aqueous/liquid and soil samples are loaded into a Marinelli beaker or other calibrated geometry (e.g., "tuna can") for counting. Air filters and swipes are placed on top of the detector, and may be retained in shipping envelope or placed in other laboratory-calibrated counting geometry material. Analysis Time (Counts): Samples are counted for 30 minutes; increased counting time will increase detection sensitivity. At 30 minutes, an uncertainty of 50% at 2 sigma can be expected to provide clear delineation of the target analyte. Other: Perform simultaneously with Gross Alpha
Americium-241 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: 59.4 keV (36%) Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L Soil/Sediment: 300 – 500 pCi/ kg Wipe: 100 – 300 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated in far left of center point of gamma spectrum (lower energies), Am-241 can be easily misidentified or have the activity miscalculated. The peak is not properly resolved and may be shifted, preventing identification at low concentrations.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Gamma Emitters cont.				
Cesium-137 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: 661.6 keV (85%) Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 200 pCi/L) Soil/Sediment: 300 – 500 pCi/kg Wipe: 100 – 300 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated at the left of center point of a typical gamma spectrum (50 – 2500 keV), the isotope is easily identified and has few other isotopic energies that might interfere with the peak or result in improper identification
Cobalt-60 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL 300 Method Ga-01-R	Emission Energies: 1173 keV (100%) and 1332 keV (100%) Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 100 pCi/L) Soil/Sediment: 100 – 300 pCi/kg Wipe: 100 – 300 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated at the right of center point of a typical gamma spectrum (50 – 2500 keV), the isotope is easily identified by two distinct and relatively equal height peaks. Co-60 has few other isotopic energies that might interfere with the peak or result in improper identification.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Gamma Emitters cont.				
Europium-154 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	<u>Emission Energies</u>: 123 keV (38%) and 1274 keV (37%) <u>Expected Identifiable Concentration (with 20% efficiency p-type)</u>: Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 60 pCi/L) Soil/Sediment: 500 – 1000 pCi/kg Wipe: 100 – 300 pCi/sample <u>Sample Preparation</u>: See Sample Preparation for Gamma Emitters, General <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Gamma Emitters, General <u>Other</u>: Situated at the far left of center point of a typical gamma spectrum (50 – 2500 keV) and halfway in the spectrum, the isotope is easily identified. Eu-154 peak at 1274 keV falls at the same energy as Na-22, which is a product of cosmic ray interactions, but is also extremely low in natural abundance. Identification can be determined solely on the 123 keV peak, as it is the higher yield of the two peaks for the isotope and has no other interferences.
Iodine-125 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	ORISE Procedure #9	<u>Emission Energies</u>: 35.49 keV (6.7%) <u>Expected Identifiable Concentration (with 20% efficiency p-type)</u>: Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 60 pCi/L) Soil/Sediment: 500 – 1000 pCi/kg Wipe: 100 – 300 pCi/sample <u>Sample Preparation</u>: The sample is prepared by matrix-specific techniques and the final sample is placed in a 16 millimeter culture tube and counted in a 3” x 3” thin window NaI(Tl) well detector attached to a pulse height analyzer. I-125 gamma counting rate is determined in the 25 to 35 keV energy range by pulse height analysis. NIST-traceable liquid standards are also counted in the same geometric configuration as the samples to determine I-125 counting efficiency. <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Gamma Emitters, General <u>Other</u>: Situated at the left of center point of a typical gamma spectrum (50 – 2500 keV). Due to the low photon energy of I-125, the Compton scattering and x-ray photons from other radionuclides may cause significant interferences in this procedure.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Gamma Emitters cont.				
Iodine-131 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: 163.9 keV (1.91%) (gamma ray of Xe-131m progeny of I-131) Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 60 pCi/L) Soil/Sediment: 500 – 1000 pCi/kg Wipe: 100 – 300 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated at the left of center point of a typical gamma spectrum (50 – 2500 keV). Due to the low gamma abundance of I-131 (Xe-131m), longer counting times may be required to obtain positive identification. Compton scattering and x-ray photons from other radionuclides may cause significant interferences in this procedure.
Iridium-192 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: 296 keV (29%), 308 keV (30%), 316 keV (83%), 468 keV (48%), 485 keV (3%), 588 keV (5%), 604 keV (8%), and 612 keV (5%) Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 100 pCi/L) Soil: 100 – 300 pCi/kg Sediment: 300 – 500 pCi/kg Wipe: 100 – 300 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated at the left of center point of a typical gamma spectrum (50 – 2500 keV), the isotope is easily identified. The peak at 296 keV falls at the same energy as Pb-214 at 295 keV, and the peak at 468 keV falls at the same energy as Rh-102m. However, the peaks at 308 and 316 keV are used in identification.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Gamma Emitters cont.				
Molybdenum-99 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: 140.51 keV (89%), 181 keV (6%), 740 keV (12%) Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 100 pCi/L) Soil: 100 – 300 pCi/kg Sediment: 300 – 500 pCi/kg Wipe: 100 – 300 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated at the right of center point of a typical gamma spectrum (50 – 2500 keV), the isotope is easily identified. The peak at 140.51 keV falls at the same energy as Tc-99m at 140.5 keV; however, the peak at 740 keV is generally used in identification.
Radium-226 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL 300 Method Ga-01-R	Emission Energies: Ra-226 is primarily an alpha emitter (95%), but does have gamma peaks that result in the remaining (5.5%) decays at 186 keV and other insignificant energies Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 500 – 1000 pCi/sample Aqueous/Liquid: 3000 – 5000 pCi/L Drinking Water: 2000 pCi/L (SDWA limit is 5 pCi/L) Soil/Sediment: 1000 – 3000 pCi/kg Wipe: 1000 – 3000 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated left of the center point of a typical gamma spectrum (50 – 2500 keV), the isotope is NOT easily identified based on potential interferences. U-235 also has a peak at 185 keV (57.2%). Based on the capability of the system and the concentrations of the isotopes, Ra-226 may not be clearly quantifiable; however, it may be determined as present in the sample.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Gamma Emitters cont.				
Ruthenium-103 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	<u>Emission Energies</u>: 497 keV (88%), 557 keV (1%), and 610 keV (6%) <u>Expected Identifiable Concentration (with 20% efficiency p-type)</u>: Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 200 pCi/L) Soil/Sediment: 100 – 300 pCi/ kg Wipe: 100 – 300 pCi/sample <u>Sample Preparation</u>: See Sample Preparation for Gamma Emitters, General <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Gamma Emitters, General <u>Other</u>: Situated left of the center point of a typical gamma spectrum (50 – 2500 keV), the isotope is easily identified with no potential interferences
Ruthenium-106 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	<u>Emission Energies</u>: Ru-106 decays solely by a weak beta decay (39 keV). Its progeny, Rh-106, has several gamma peaks that can be used in analysis. These include 511 keV (21%), 622 keV (11%), 1050 keV (1.5%), 1128 keV (0.4%), and 1562 keV (0.2%). <u>Expected Identifiable Concentration (with 20% efficiency p-type)</u>: Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 30 pCi/L) Soil/Sediment: 500 – 1000 pCi/kg Wipe: 100 – 300 pCi/sample <u>Sample Preparation</u>: See Sample Preparation for Gamma Emitters, General <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Gamma Emitters, General <u>Other</u>: Situated to the left and right of the center point of a typical gamma spectrum (50 – 2500 keV), the isotope Rh-106 is not easily identified. The peak at 511 keV (the most abundant peak at 20%) corresponds to numerous other isotopes. The peak at 622 keV corresponds to the peak for I-132, a potential fission product, which is also the means of production for Ru-106. The peaks at 1050 keV, 1128 keV, and 1562 keV have no known interferences but have low yields.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Gamma Emitters cont.				
Selenium-75 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: Se-175 decays by beta decay to its progeny, stable As-75. Se-75 has several gamma peaks that can be used in analysis. These include 96.73 keV (3.4%), 121.12 keV (17.2%), 136.0 keV (58.3%), 264.66 keV (58.9%), 279.54 keV (25%), and 400.66 keV (11.47%). Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 100 – 300 pCi/sample Aqueous/Liquid: 30 – 50 pCi/L Drinking Water: 20 pCi/L (SDWA limit is 30 pCi/L) Soil/Sediment: 500 – 1000 pCi/kg Wipe: 100 – 300 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated to the left and right of the center point of a typical gamma spectrum (50 – 2500 keV), the isotope Se-75 is easily identified with the two primary peaks at 136 keV and 264.66 keV
Uranium-235 (gamma emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis	EPA Method 901.1 SM Method 7120 HASL-300 Method Ga-01-R	Emission Energies: U-235 has peaks at 144 keV (11%), 163 keV (5%), 185 keV (57%), 202 keV (1%), and 205 keV (5%) Expected Identifiable Concentration (with 20% efficiency p-type): Air Filter: 1000 – 3000 pCi/sample Aqueous/Liquid: 3000 – 5000 pCi/L Drinking Water: 2000 pCi/L (SDWA limit is 5 pCi/L) Soil/Sediment: 1000 – 3000 pCi/kg Wipe: 1000 – 3000 pCi/sample Sample Preparation: See Sample Preparation for Gamma Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Gamma Emitters, General Other: Situated left of the center point of a typical gamma spectrum (50 – 2500 keV), the isotope is NOT easily identified based on potential interferences and decay yields. Depending on the source and concentration of the isotope in the sample, it may be possible to determine that the isotope is present. Pa-234, a progeny of the decay of U-238, has gamma energies of 185 keV and 203 keV. Th-227, a progeny of U-235, has a gamma peak at 185 keV, and Ir-192 has a gamma peak at 205 keV.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha and Beta Emitters				
Gross Alpha and Beta	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gas-flow Proportional Detector or Solid Scintillation Detector	EPA Method 900.0 SM Method 7110B ORISE Method AP1 FRMAC, Vol 2, pg. 33	Emission Energies: Alpha emitters > 3.9 MeV; beta emitters > 0.1 MeV Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time. See specific alpha- and beta-emitting radionuclides for expected identifiable concentrations. Sample Preparation: Aqueous and liquid samples are prepared by evaporation and transfered to a planchet for final evaporation and counting. Soil and sediment samples are dried, ground, and dispersed across the planchet for further drying and counting. Air filters and wipes are counted as is. If the sample is larger than can be counted via a planchet counting system, use hand-held instrument detectors. Analysis Time (Counts): Sample is counted using either a gas-flow proportional detector or solid scintillation detector for 30 minutes Other: Perform simultaneously with Gamma Spectrometry analysis for water, liquid, soil, and sediment. Perform after Gamma Spectrometry analysis for air filters and surface wipes. Measures only gross alpha or gross beta (presence of alpha and beta decay particles), with no isotopic determination. If alpha or beta radiation is detected, proceed to alpha spectrum or gamma spectrum for determination of specific radioisotopes.
Alpha Emitters Americium-241 Californium-252 Radium-226 Uranium-234 Uranium-235 Uranium-238	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05 ORISE Method AP3	Emission Energies: Refer to selected alpha-emitting radionuclides for isotope-specific emission energies Expected Identifiable Concentration: 15 pCi/L for aqueous liquids and drinking water samples (EPA 40 CFR 141.66, Alpha without Uranium and Radon) 5 pCi/g for soils and sediments (CERCLA, Ra-226 limit) 2 E-14 µCi/mL for air filter sample (10 CFR 20 Subpart O, Appendix B, Table 2 based on most conservative value for effluent concentrations, Pu-238 and Am-241) 220 pCi/swipe for swipe sample (49 CRF 173.443) Sample Preparation: Depending on the sample matrix, pretreatment (e.g., grinding, sieving) may be necessary to obtain a homogeneous sample. The sample is processed by various chemical separation methods (e.g., acid digestion, chemical fusion, co-precipitation, liquid-liquid extraction, ion exchange), along with method-specific radioisotopic tracers, to isolate and extract the radioisotope(s) in their purest form. The radioisotope(s) extract is 1) mounted as a thin layer on an appropriate alpha spectrometry counting geometry (depending on the separation method used) by electrodeposition, evaporation of organic solvent, or fluoride precipitation, or 2) extracted into liquid scintillation cocktail and counted by PERALS® spectrometry system.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha and Beta Emitters (cont.)				
Alpha Emitters (cont.) Americium-241 Californium-252 Radium-226 Uranium-234 Uranium-235 Uranium-238	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05 ORISE Method AP3	Analysis Time (Counts): Samples are counted, depending on the sample activity, for a sufficient length of time (generally one to eight hours) to provide clear delineation of the target nuclide(s) and/or tracer, and to ensure good alpha peak resolution (Full Width Half-Maximum) of approximately: 20 – 50 keV for electrodeposited and organically evaporated samples by alpha spectrometry, 25 – 200 keV for precipitated samples by alpha spectrometry, and 400 – 500 keV for liquid scintillation counted samples. Sample count may be stopped at any time if clear evidence is obtained as to the isotope or tracer present in the sample with well resolved peak(s); increased counting time will increase detection sensitivity. Other: Using gross alpha detection, if results are computed as alpha activity greater than shown for expected identifiable concentration, analyze sample with alpha spectrum analysis
Beta Emitter Strontium-90	Aqueous/Liquid Drinking Water	Beta Counting	SM Method 7500-Sr B HASL-300 Method Sr-03-RC	Emission Energies: 195.8 keV Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time Sample Preparation: Aqueous and liquid samples are prepared by adding a known amount of inactive strontium ions (e.g., $Sr(NO_3)_2$) as a "carrier." The carrier, alkaline earths, and rare earths are precipitated as the carbonate to concentrate the radiostrontium. The carrier, along with the radionuclides of strontium, is separated from other radioactive elements and inactive sample solids by precipitation as $Sr(NO_3)_2$ from fuming nitric acid solution. The strontium carrier, together with the radionuclides of strontium, finally is precipitated as $SrCO_3$, which is dried, weighed to determine recovery of carrier, and measured for radioactivity. The activity in the final precipitate is due to radioactive strontium only, because all other radioactive elements have been removed. A correction is applied to compensate for losses of carrier and activity during the various purification steps. Analysis Time (Counts): Sample is counted using a gas-flow proportional detector for 60 minutes. Increased counting time will increase detection sensitivity. Other: Radioactive barium (Ba-140, La-140) interferes in the determination of radioactive strontium inasmuch as it precipitates with the radioactive strontium. Eliminate this interference by adding inactive barium nitrate as carrier and separating this from the strontium by precipitating barium chromate in acetate buffer solution. Radium isotopes also are eliminated by this treatment. In hard water, some calcium nitrate may be coprecipitated with strontium nitrate and can cause errors in recovery of the final precipitate and in measuring its activity. Eliminate this interference by repeated precipitations of strontium as the nitrate followed by leaching the strontium nitrate with acetone. CAUTION: For total radiostrontium, count the precipitate within three to four hours after the final separation and before ingrowth of Y-90.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha and Beta Emitters cont.				
Beta Emitter Strontium-90	Air Filters Soil and Sediment Surface Wipes	Beta Counting	HASL-300 Method Sr-03-RC	Emission Energies: 195.8 keV Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time Sample Preparation: Strontium is separated from Ca, other fission products, and natural radioactive elements. Fuming nitric acid separations removes the Ca and most other interfering ions. Ra, Pb, and Ba are removed with barium chromate. Traces of other fission products are scavenged with iron hydroxide. After Sr-90 and Y-90 equilibrium has been attained, Y-90 is precipitated as the hydroxide and converted to oxalate for counting on a low-background gas proportional beta counter. Chemical yield is determined with Sr-85 tracer by counting in a gamma well detector. Analysis Time (Counts): Sample is counted using a gas-flow proportional detector for 60 minutes. Increased counting time will increase detection sensitivity
Technetium-99	Aqueous/Liquid Drinking Water	Liquid Scintillation	HASL-300 Method Tc-02-RC	Emission Energies: 84.6 keV Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time Sample Preparation: The sample containing Tc-99 is mixed with Tc-95m added as a gamma-emitting tracer. The two isotopes of Tc are brought to an isotopic equilibrium and separated from other elements by ferrous and ferric hydroxide coprecipitation. The precipitate is dissolved with dilute nitric acid and passed through a commercially available resin column (TEVA® resin) which is highly specific for Tc in the pertechnetate form. The resin is washed with dilute nitric acid to remove possible interferences and then it is extruded directly into a suitable liquid scintillation cocktail. Analysis Time (Counts): The sample is typically counted for one hour to simultaneously determine Tc-99 activity and the Tc-95m radiochemical yield. Quench/efficiency calibration curves need to be established for the liquid scintillation spectrometer for both Tc-95m and Tc-99. Other: Tritium may follow technetium due to the absorption of some tritium-labeled compounds by the resin. Possible tritium interferences are eliminated by setting the Tc counting window above the maximum energy of tritium beta particles.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha and Beta Emitters cont.				
Technetium-99	Air Filters Soil and Sediment Surface Wipes	Liquid Scintillation	ORISE Method AP5	Emission Energies: 84.6 keV Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time Sample Preparation: Solid samples are leached with dilute nitric acid. The leachates are passed through a commercially-available resin column (TEVA® resin) which is highly specific for Tc in the pertechnetate form. The Tc is absorbed onto the extraction resin. The resin is added to a scintillation vial containing an appropriate cocktail and counted using a liquid scintillation analyzer. Most interfering beta emitting radionuclides (including C-14, P-32, S-35, Sr-90, Y-90, and Th-234) are effectively removed using TEVA® resin under the conditions in this procedure. Analysis Time (Counts): The sample is typically counted for one hour to determine the Tc-99 activity. Quench/efficiency calibration curve needs to be established for the liquid scintillation spectrometer for Tc-99. Other: Tritium may follow technetium due to the absorption of some tritium-labeled compounds by the resin. Possible tritium interferences are eliminated by setting the Tc counting window above the maximum energy of tritium beta particles.
Tritium (Hydrogen-3)	Aqueous/Liquid Drinking Water	Liquid Scintillation	EPA Method 906.0	Emission Energies: 18.59 keV Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time Sample Preparation: An unpreserved 100-mL aliquot of a drinking water sample is distilled after adjusting pH with a small amount of sodium hydroxide and adding potassium permanganate. The alkaline treatment prevents other radionuclides, such as radioiodine and radiocarbon, from distilling with the tritium. The permanganate treatment oxidizes trace organics that may be present in the sample and prevents their appearance in the distillate. To determine the concentration of tritium, the middle fraction of the distillate is used, because the early and late fractions are more apt to contain materials interfering with the liquid scintillation counting process. A portion of this collected fraction is added to a liquid scintillator cocktail, and the solution is mixed, dark adapted, and counted for beta particle activity. The efficiency of the system can be determined by the use of prepared tritiated water standards having the same density and color as the sample. Analysis Time (Counts): The sample is typically counted for one hour using a liquid scintillation spectrometer. Increased counting time will increase detection sensitivity. Other: Other beta emitters may follow tritium during the distillation process and interfere with the measurement. Possible interferences are eliminated by setting the tritium counting window below the energies of the interfering beta particles from C-14, Tc-99, etc.

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha and Beta Emitters cont.				
Tritium (Hydrogen-3) (cont.)	Soil and Sediment Surface Wipes	Liquid Scintillation	ORISE Method AP2	Emission Energies: 18.59 keV Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time Sample Preparation: For solid samples, an appropriate volume of water is added to facilitate distillation. Certain solid samples may be refluxed to ensure distribution of any tritium that may be in the sample. The sample may be spiked with a standard tritium solution to evaluate quenching and counting efficiency. After the sample has been distilled, an aliquot of the distillate is added to a scintillation cocktail and the sample is counted using a liquid scintillation analyzer. Analysis Time (Counts): The sample is typically counted for 90 minutes using a liquid scintillation spectrometer. Increased counting time will increase detection sensitivity. Other: Other volatile radionuclides such as iodine and carbon isotopes may interfere and may require that the sample be made alkaline using solid sodium hydroxide before distillation. Organic impurities may interfere and may require the addition of an oxidizing agent to the sample as well as spiking the samples with a standard tritium solution. The addition of a standard tritium solution to each sample allows for counting efficiencies to be calculated for each individual sample.
Beta and Gamma Emitters Cobalt-60 Cesium-137 Europium-154 Iodine-131 Iridium-192 Molybdenum-99 Ruthenium-103 Ruthenium-106	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Gamma Spectrometry Analysis and Gross Beta	EPA Method 900.0 EPA EMSL Method LV 053917 ORISE Method AP1	Emission Energies: Refer to specific gamma-emitting radionuclides for isotope-specific emission energies Expected Identifiable Concentration (with 20% efficiency p-type): 8 pCi/L for aqueous and drinking water samples (NBS Handbook, Edition 69, Strontium-90) 30 pCi/L for aqueous liquids and drinking water samples (NBS Handbook, Edition 69, Ruthenium-106) 5 pCi/g for soils and sediments (CERCLA, Ra-226 limit) 6 E-12 µCi/mL for air filter sample (10 CFR 20 Subpart O, Appendix B, Table 2 based on most conservative value for effluent concentrations, Strontium-90) 220 pCi/swipe for swipe sample (49 CFR 1173.443) Sample Preparation: See sample preparation for Gamma Emitters, General Analysis Time (Counts): See analysis time (counts) for Gamma Emitters, General

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha Emitters				
Alpha Emitters, General	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	Emission Energies: Refer to specific alpha-emitting radionuclides for isotope-specific emission energies Expected Identifiable Concentration: The expected identifiable concentration depends on sample size, counting system characteristics, background, and counting time. See specific alpha-emitting radionuclides for expected identifiable concentrations. Sample Preparation: Depending on the sample matrix, pretreatment (e.g., grinding, sieving) may be necessary to obtain a homogeneous sample. The sample is processed by various chemical separation methods (e.g., acid digestion, chemical fusion, co-precipitation, liquid-liquid extraction, ion exchange), along with method-specific radioisotopic tracers, to isolate and extract the radioisotope(s) in their purest form. The radioisotope(s) extract is 1) mounted as a thin layer on an appropriate alpha spectrometry counting geometry (depending on the separation method used) by electrodeposition, evaporation of organic solvent, or fluoride precipitation, or 2) extracted into liquid scintillation cocktail and counted by PERALS® spectrometry system. Analysis Time (Counts): Samples are counted, depending on the sample activity, for a sufficient length of time (generally one to eight hours) to provide clear delineation of the target nuclide(s) and/or tracer, and to ensure good alpha peak resolution (Full Width Half-Maximum) of approximately: 20 – 50 keV for electrodeposited and organically evaporated samples by alpha spectrometry, 25 – 200 keV for precipitated samples by alpha spectrometry, and 400 – 500 keV for liquid scintillation counted samples. Sample count may be stopped at any time if clear evidence is obtained as to the isotope or tracer present in the sample with well-resolved peak(s); increased counting time will increase detection sensitivity. Other: Perform alpha spectrometry upon positive identification of gross alpha at greater than 30 pCi/L (water), 5 pCi/g (soil or sediment), or 2.0 E-8 µCi/mL (air filter or wipe). Requires experience in determination of multiple peak alpha analysis. It is assumed that if only one isotope is present, it will be apparent. Any sample that produces multiple peaks and has multiple isotopes identified should have the spectrum sent to EPA ORIA or a designated laboratory for definitive examination.
Americium-241 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	Emission Energies: 5.486 MeV (85%) and 5.443 MeV (13%) Expected Identifiable Concentration: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time Sample Preparation: See Sample Preparation for Alpha Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Alpha Emitters, General

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha Emitters (cont.)				
Californium-252 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	Emission Energies: 6.118 MeV (84%) and 6.076 MeV (16%) Expected Identifiable Concentration: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time Sample Preparation: See Sample Preparation for Alpha Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Alpha Emitters, General
Curium-244 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	Emission Energies: 5.805 MeV (76%) and 5.763 MeV (24%) Expected Identifiable Concentration: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time Sample Preparation: See Sample Preparation for Alpha Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Alpha Emitters, General
Plutonium-238 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	Emission Energies: 5.499 MeV (72%) and 5.456 MeV (28%) Expected Identifiable Concentration: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time Sample Preparation: See Sample Preparation for Alpha Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Alpha Emitters, General
Plutonium-239 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	Emission Energies: 5.156 MeV (71%), 5.143 MeV (17%), and 5.105 MeV (12%) Expected Identifiable Concentration: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time Sample Preparation: See Sample Preparation for Alpha Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Alpha Emitters, General

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha Emitters (cont.)				
Polonium-210 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	HASL-300 Method Po-02-RC EPA Method 111	<u>Emission Energies</u>: 5.305 MeV <u>Expected Identifiable Concentration</u>: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time <u>Sample Preparation</u>: See Sample Preparation for Alpha Emitters, General <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Alpha Emitters, General
Radium-226 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	ORISE Method AP7 EPA Method EMSL-19 ASTM Method D3084-05	<u>Emission Energies</u>: 4.782 MeV (95%) and 4.599 MeV (5%) <u>Expected Identifiable Concentration</u>: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time <u>Sample Preparation</u>: See Sample Preparation for Alpha Emitters, General <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Alpha Emitters, General
Uranium-234 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	<u>Emission Energies</u>: 4.774 MeV (71%) and 4.722 MeV (28%) <u>Expected Identifiable Concentration</u>: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time <u>Sample Preparation</u>: See Sample Preparation for Alpha Emitters, General <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Alpha Emitters, General
Uranium-235 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	<u>Emission Energies</u>: 4.397 MeV (55%), 4.366 MeV (17%), 4.214 MeV (6%), and 4.596 MeV (5%) <u>Expected Identifiable Concentration</u>: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time <u>Sample Preparation</u>: See Sample Preparation for Alpha Emitters, General <u>Analysis Time (Counts)</u>: See Analysis Time (Counts) for Alpha Emitters, General

Table 2: Rapid Screening and Preliminary Identification Techniques and Methods for the Radiochemical Analytes Listed in SAM (cont.)

Analyte	Matrix	Technique	Reference Source *	Comments
Alpha Emitters cont.				
Uranium-238 (alpha emitter)	Air Filters Aqueous/Liquid Drinking Water Soil and Sediment Surface Wipes	Alpha Spectrometry Analysis	EPA Method 907.0 EPA Method EMSL-19 ASTM Method D3084-05	Emission Energies: 4.200 MeV (77%) and 4.115 MeV (23%) Expected Identifiable Concentration: The expected identifiable concentration to which this method is applicable depends on sample size, counting system characteristics, background, and counting time Sample Preparation: See Sample Preparation for Alpha Emitters, General Analysis Time (Counts): See Analysis Time (Counts) for Alpha Emitters, General

*SAM methods listed in this column can be located using the U.S. Environmental Protection Agency, National Homeland Security Research Center's (NHSRC), *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events* (www.epa.gov/sam). SAM is intended to be used concurrently with this Rapid Screening and Preliminary Identification Techniques and Methods document. Full citations for references not accessible through SAM are provided in Section 3.0 of this document.

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