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Clandestine Amphetamine-Derived Drug Laboratories: Remediation Guidelines for Residential Settings

Prabjit Barn, Michele Wiens, Patti Dods

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Summary

- Clandestine labs produce illegal substances using a variety of chemicals and manufacturing processes.
- Clandestine labs can be housed in a variety of structures, including residential and non-residential buildings. In particular, residential buildings previously used for clandestine labs can pose health concerns to re-occupants.
- Amphetamine-derived drug labs are the most common type of clandestine lab found in most provinces.
- Here we present guidelines on the remediation of clandestine amphetamine-derived drug labs for the purposes of protecting the health of re-occupants. These guidelines do not address other health hazards that may be encountered during cleanup.[a]
- These guidelines are derived from instructions for methamphetamine (meth) lab cleanup in the United States,[1] New Zealand,[2] and Australia.[3]
- This document is intended for use by public health officials, municipal agencies, law enforcement agencies, and property owners to address decontamination of former drug labs.

Background

The illegal manufacturing of amphetamine-derived drugs is an increasing problem in Canada. These drugs include methamphetamine (meth), methylenedioxymethamphetamine (MDMA, commonly called ecstasy) and methylenedioxyamphetamine (MDA). In 2009, 45 clandestine labs were seized by various Canadian police agencies.[4] The majority of labs seized were meth labs—twice as many meth labs were seized as MDMA labs (Figure 1).

[a] Due to similarities between the chemical properties of ecstasy and methamphetamine, this document recommends similar cleanup methods be followed for both compounds.

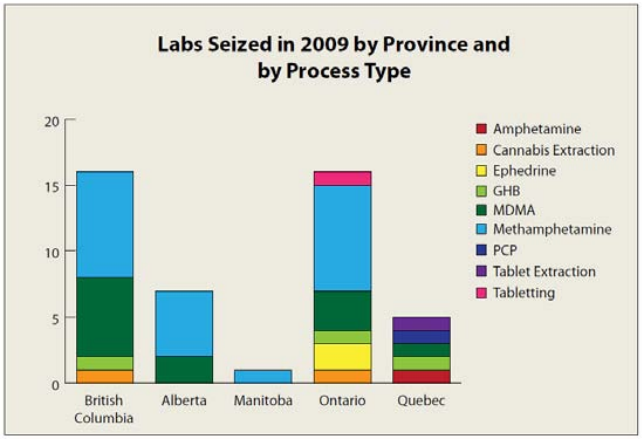

Figure 1. *The number of clandestine labs seized by province and by process type (RCMP, 2010)*[4]

Clandestine (clan) labs may be found in a variety of structures, including private dwellings, townhomes, apartments, motels and vehicles. The sophistication of these labs varies widely, from individuals at home following online instruction to large elaborate setups.

These operations may present a danger to the health of members of the community in which they operate. The most obvious dangers posed are fire and explosion risks to neighbours and law enforcement personnel. Less obvious are the health risks that residual chemicals such as volatile organic compounds from drug manufacturing processes present to re-occupants of the structure. Poor disposal practices may also pose a human health risk to re-occupants and to surrounding neighbours.

Exposure of building occupants to residual chemicals is dependent on several factors including the location of contamination within the structure, whether it is present (e.g., in air and/or on surfaces), and the behavioural patterns of re-occupants. In turn, the risk of re-occupants experiencing health effects upon exposure to residual chemicals depends on many factors including the inherent toxicity of the residue, the intensity and frequency of exposure, and the duration of exposure to toxic substances.

Exposure

Potential exposure to residual chemicals for re-occupants may occur via inhalation and oral and/or dermal pathways.

Inhalation

While inhalation exposure to volatile organic carbons (VOCs) and gases may present a health risk to first responders, proper venting of residences following lab seizure should allow for the dissipation of most airborne chemicals. In the case of large spills or residual pools of volatile chemicals trapped in the sewer lines, it is possible that re-occupants could experience inhalation exposure to chemicals if the structure is not thoroughly cleaned. Although removal of volatile chemicals through ventilation will mitigate most of the potential exposures occurring via inhalation, some chemicals may be further inhaled when they are re-entrained from surfaces and furnishings in the structure. For this reason, cleaning of surfaces and removal of contaminated furnishings is necessary.

Oral and dermal

Oral and dermal contact with residual chemicals on contaminated surfaces may also occur. A study by Martyny et al. (2004) examined chemical exposures associated with clandestine methamphetamine laboratories.[5] In this study, authors reported that methamphetamine became aerosolized during the filtering and crystallization stages of manufacturing. Once in the air, these aerosols can settle throughout the residence, leading to widespread contamination in the building. Residues on accessible surfaces, such as walls, floors, kitchen appliances and furniture in frequently used rooms, can be potential sources of exposure. The distribution of chemical residues in a building used as a clandestine lab will depend upon the drug manufacturing processes, the site of manufacturing, and the design of the ventilation system.

Levels and patterns of exposure

Preliminary data from samples collected in a residence used for MDA manufacturing suggest that MDA residue may spread throughout the structure, even if the lab is located in the basement of the residence (BCCDC, unpublished data). MDA was detected on a child's training toilet (2,418 µg/sample) located in the master bathroom three stories above the lab (BCCDC, unpublished data). MDA residue was also detected on bedroom blinds, on a child's crib, and on counters in the master bathroom (BCCDC, unpublished data). Martyny et al. (2004) reported levels of meth residue in former labs, ranging from non-detectable to 16,000 µg/sample.[5] Along with the location of contaminants, behavioural patterns will influence the frequency of exposure. Behaviours that influence the extent of exposure to residual materials in clan labs are dependent upon the age. Toddlers are at greatest risk of exposure to residue from oral exposure due to constant placing of objects and

fingers in their mouths. Toddlers are also likely to be the most highly exposed to residues located on floors, carpets and furniture, through oral and dermal exposure.

Toxicity

The probability that residual chemicals will lead to adverse health effects is dependent on the amount of exposure and the toxicity of the residues. Clan labs contain a variety of contaminants and by-products that do not have predictable drug effects.[1] Composition of residues will also differ between labs. Toxicity information and occupational exposure levels for some of these chemicals are listed in Appendix A.

Existing remediation levels

The goal of cleaning clan labs is to prevent re-occupants from experiencing adverse health effects from exposure to residual chemicals from drug manufacturing processes. Most guidelines emphasize cleanup measures to remove residual chemicals in order to prevent exposures. In the United States, over 20 states have established cleanup guidelines with remediation levels set according to "what are believed to be conservative to account for scientific uncertainty while at the same time establishing a standard/ guideline that sites remediation contractors can meet" rather than set according to health-based criteria.[1,2,b,c]

Due to the variation in contaminants and their distribution in clan labs, there is not sufficient data to recommend concentration or mass-based cleanup levels for specific contaminants. However, meth is often used as an indicator of contamination.[1] For meth residues, the most common cleanup standard for many US states is 0.1 µg/100 cm^2 but can vary from 0.05 µg/100m^2 to 0.5 µg/100 cm^2.[1] These values are based on analytical detection limits and feasibility from a remediation perspective rather than being based solely on health endpoints.[3-5]

[b] In Appendix B, New Zealand Ministry of Health's guidelines[2] provide a list of US states with regulations or standards for drug laboratory cleanup. As well, various states have separate guidance documents.[1-3,6-30]

[c] Research by Hammon and Griffin (2007) on Colorado's toxicity reference values indicated that all of the proposed standards would be protective of human health exposure.[31] Colorado selected 0.5 µg/100 cm^2 as the final cleanup standard for meth residues.

Preliminary Assessment

Prior to the commencement of cleanup, a preliminary assessment of the extent of contamination should be conducted. A preliminary assessment can be made once law enforcement officials have given clearance. Since clan labs may differ in set up and location, it is necessary that each lab be assessed individually using a structured framework. In some cases, factors other than the presence of residual chemicals may result in a determination that the building is not fit for re-occupancy.

Contractors performing remediation should be supplied with documented information to assist them in determining necessary cleanup procedures. The following information should be collected and forwarded to contractors:

1. drugs manufactured at site;
2. list of chemicals and equipment found at site;
3. method of drug manufacture, if known;
4. set up of equipment and forced ventilation systems;
5. location of manufacturing (cooking), processing, and storage areas;
6. visible signs of drug manufacturing (e.g., extensive yellow staining from iodine use).

The person or agency responsible for the cleanup should:

- Determine whether the heating, air-conditioning, or ventilation (HVAC) systems serve more than one unit or structure. Examples of multi-unit buildings are motels, apartments, and townhouses. If the ventilation system is shared by more than one unit, the responsible official should determine whether neighbouring units may have been contaminated.
- Examine the structure and surrounding property for contamination by chemical spills and/or waste deposits present after bulk chemical removal by HazMat personnel. The responsible party should arrange removal and disposal, by qualified personnel, of any drums, containers or other bulk quantities of hazardous materials.

- Inspect the property for visible signs of soil, groundwater or septic bed contamination. If evidence of contamination or potential for contamination is found in soil, groundwater or septic systems, officials must notify the agency responsible for regulation of these contaminants and ensure cleanup to any applicable standards.

- Inspect the property for hazards such as needles and broken glass, as well as structural hazards such as fire damage.

Those responsible for cleanup should also assess the feasibility and need for pre- and post-cleanup sampling. The sampling design, including sampling locations, number of samples collected, sampling procedures, and analysis methods need to be considered. Guidance on sampling has been developed by organizations such as the US Environmental Protection Agency.[1]

See Appendix B for a sampling procedure for methamphetamine.

Cleanup Recommendations

The following section describes steps recommended in the cleanup of clandestine amphetamine-derived labs. See Appendix C for a summary of these procedures.

Prior to cleaning interior surfaces and ventilation systems, all equipment used for manufacturing should be dismantled and bulk chemicals removed. In certain cases, the property owner may need to consult with law enforcement officials to ensure all required information has been collected from the crime scene before cleanup commences.

1. Ventilation/airing out

Solvents and other volatile chemicals used in the manufacturing process may be present in the air and absorbed by walls and furnishings of clan labs and surrounding structures. While labs are generally vented throughout the criminal investigation and during the removal of bulk chemicals, they may be sealed for security reasons after law enforcement officials have left the scene. This short-term venting may not allow sufficient time for absorbed chemicals to volatilize and airborne chemicals to be dispersed. Proper ventilation should be continued throughout the cleanup process. Ventilation can be aided by opening windows and using fans and/or negative air units equipped with a high-efficiency particulate air (HEPA) filter.[2]

2. Chemical spills and residues

Cleanup of chemical spills and residues should be completed by personnel trained to deal with chemical hazards. If the spills or residues are found to contain acids or bases, chemicals should be neutralized before cleaning and disposal. Acids may be neutralized with solutions of sodium bicarbonate (baking soda) and bases may be neutralized by using weak acidic solutions of vinegar (acetic acid) in water.[11] Solid spills and residues can be scooped up and packaged for proper waste disposal. Liquids can be absorbed with clay or other non-reactive material and packaged for disposal.[11]

3. Heating/ventilating/air-conditioning systems (HVAC)

In multi-unit buildings, ventilation systems, as well as heating and air-conditioning systems, should be checked to determine whether contamination may have spread through common ducts beyond the unit used as a lab. Heating and air-conditioning systems can collect chemical-containing dust and other debris which can then be redistributed throughout the structure, resulting in widespread contamination. For this reason, it is important to ensure that the ventilation system is thoroughly cleaned as part of remediation.

The number of units potentially contaminated should be determined. In multi-unit buildings, the same ventilation system may serve more than one unit or structure. For this reason, property owners of motels, apartments, row houses or other multiple-family dwellings should take wipe samples from adjacent or connected areas/rooms/units, working outward from the lab site until samples show low levels or no contamination.[22] In areas that show contamination, the following procedures should be followed:

- Any ventilation system suspected of being contaminated and that is constructed of non-porous material such as sheet metal should be vacuumed using a high-efficiency particulate air filter (HEPA).

- Ductwork may also need to be washed to arm's length using water and detergent until all contaminants are removed.

- All air filters in the system should be replaced.

- Air diffusers and vents should be removed and cleaned or replaced.

- All surfaces near system inlets and outlets should also be cleaned with detergent and water.

4. Sewer, septic, and plumbing systems

As dumping of liquid and sludge waste products into the household plumbing system may be the primary disposal method used by drug manufacturers, it is possible that drains, traps, sewer and/or septic systems may contain hazardous materials. All drains should be checked for visible signs of staining. Plumbing fixtures that are visibly contaminated beyond normal household wear may be difficult to clean and therefore need to be replaced. Some materials such as stainless steel can be successfully cleaned. If staining or presence of volatile organic compounds from earlier testing indicates dumping into municipal sewer systems took place, household plumbing should be aggressively flushed. Generous flushing should reduce the concentration of contaminants and resulting odours in the plumbing system.

Units connected to municipal sewer systems will have high dilution rates, so it is unlikely that disposal of meth-related waste will pose a health risk to occupants. However, local authorities should still be informed that chemicals associated with drug manufacturing might have been disposed of into the sanitary sewer.

Dumping of chemicals in units that use a septic system may result in contamination of the septic system and surrounding soil. If the property is on a septic tank system and tank liquid is suspected to be contaminated, sampling of tank liquid should be conducted to determine the extent of contamination. The appropriate authorities should be notified that testing needs to be conducted. Depending on the results of the analysis, the contents of the tank may need to be disposed of as hazardous waste.

5. Porous materials and furnishings

Absorbent materials may collect residual dust and powder from chemicals used in drug manufacturing. Porous materials may also accumulate vapours that are created and dispersed during the manufacturing (cooking) process.[1-3] Items in this class may be split into two groups: 1) those that are machine washable including some drapes, clothing and bedding, and 2) those that are not machine-washable, such as carpeting, upholstered furniture, mattresses and light fixtures.

For all porous items, remediation will include either cleaning or disposal. If the property owner does not wish to dispose of contaminated items such as furniture, he/she must prove, through testing, that items are not contaminated. Since all clan labs will be set up differently and located in varying types of structures, professional judgment may also be required in making decisions regarding the cleaning or disposal of items. In making this decision, the most important consideration is the potential for human exposure.

Items that are heavily stained or contain odours from the manufacturing process should be discarded.

In areas of mild to moderate contamination, cleaning may be an acceptable course of action. If the owner does not wish to dispose of machine washable goods, these items should be thoroughly laundered using detergent. All personal items that are not discarded must be laundered.

Porous items that are not discarded and cannot be machine washed should be HEPA vacuumed, followed by at least one hot water detergent scrubbing or steam cleaning.[1-3] It is possible that even after thorough cleaning of carpets and other porous materials, residue will remain and porous fabrics will need to be discarded. Residual contaminants on carpets could provide a source of exposure for toddlers and young children, so it is important that these be removed if still contaminated. Floors must be HEPA vacuumed following the removal of carpets.

6. Non-porous surfaces

Hard interior surfaces such as walls, tile and wood flooring, ceilings and paneling, and hard furniture or appliances may contain chemical residues from drug manufacturing processes, especially in areas in and adjacent to where manufacturing and preparation took place.[1-3] It is important that floors, walls, tile, and doors be thoroughly cleaned, as occupants may have frequent contact with these surfaces. Countertops, tables, and other surfaces used for food preparation may be additional sources of exposure (via ingestion) if these surfaces are not thoroughly cleaned.

If a surface has visible contamination or staining, complete removal and replacement of that section of the surface is recommended. This may include removal and replacement of wallboard, floor coverings

and counters. For non-porous surfaces that are not discarded, intensive cleaning with a detergent-water solution is recommended.[1-3] Floors should be HEPA vacuumed before being washed. The ceiling should be cleaned first, followed by walls, and finally floors and other surfaces. This procedure should be repeated using a fresh detergent solution and fresh rinse water.

Special care should be taken throughout the assessment process to clean high-traffic areas and pathways, such as hallways to and from the cooking areas, and between chemical storage and cooking areas.

7. Household appliances

Appliances that show visible contamination in areas that are difficult to clean should be discarded. All other appliances can be evaluated on a case-by-case basis with attention to use during drug manufacturing; proximity to lab activity; use in the home; ability to be cleaned; and cost-benefit of disposal vs cleaning.[22]

8. Encapsulation

In certain situations, it may be necessary to repaint or reseal hard surfaces as part of the remediation process. This step should occur after the hard surfaces have been cleaned. Repainting and/or sealing will create a physical barrier between any residual contaminants that were not removed by cleaning. This will also prevent any residual chemicals from further volatilization. In areas of high contamination, such as those rooms in which manufacturing took place, the ceilings and walls should be repainted with a non-water-based paint or sealed with a non-water-based coating.[1-3] Floors that are highly contaminated and of a porous nature should be removed and replaced if they cannot be effectively cleaned. Floors constructed of materials such as laminate or vinyl can either be removed and replaced or recovered with new flooring after cleaning. Ceramic or stone-tiled surfaces, floors, countertops, walls, or other ceramic or stone-tiled surfaces in the rooms used for the manufacturing, can be removed, reglazed or grout stained using an epoxy-based stain. Wooden materials (floors, walls, ceilings, cabinets or other wooden materials in the rooms used for the manufacturing) can be removed or cleaned and then sealed with a non-water-based coating.[1-3]

Although thorough cleaning of hard surfaces should effectively remove all traces of contaminants, signs of visible contamination and/or odours may remain. Such surfaces should recleaned and then repainted or resealed, or replaced.

9. Exterior contamination

The property surrounding the structure should be inspected for evidence of contamination. Liquid and solid waste materials may have been dumped, buried or burned outside of the structure. Where waste materials are dumped, soil and groundwater may be contaminated. If soil or groundwater contamination is suspected, the appropriate agency should be contacted regarding proper assessment and cleanup.

10. Post-remediation sampling

Conduct post-remediation sampling, if applicable. Ensure that the structure and all items and surfaces within the structure are completely dry prior to sampling.

Knowledge Gaps

Further field research is needed to validate the effectiveness of these recommended procedures in minimizing exposure of re-occupants to chemical residues resulting from the manufacturing of amphetamine-derived substances. Some research has been conducted to validate available cleanup procedures,[22,32-37] but additional research can allow for more specific recommendations in remediation protocols.

Although some guideline values are available to assess the level of contamination in former clan labs, namely from the US, more research is needed to determine: 1) what levels of residue remain following suggested cleanup guidelines, and 2) what levels of residue are acceptable from a health protection perspective.

Roles and Responsibilities

The roles and responsibilities of the involved agencies will vary across Canada. It is outside the mandate of the National Collaborating Centre for Environmental Health to designate responsibilities to the various agencies.

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Appendix A: Chemicals commonly used in methamphetamine and ecstasy manufacturing

Toxicity summary for chemicals commonly used in the manufacturing of methamphetamine and/or ecstasy, and chemicals produced during the manufacturing process+

Substance (Including Chemical Abstracts Service [CAS] Number)	LD_{50} (g/kg bw)[a]	LC_{50}	Critical Effect Dose[b]	IARC[c] Classification	ACGIH[d] Exposure Limit (TWA)[e] mg/m^3
Acetic Acid 64-19-7	3.31–3.53	11.4 mg/L/hr			25
Acetone 67-64-1	5.8–9.9	76 mg/L/4 hr 50.1 mg/L/8 hr	Exposure: oral Endpoint: nephropathy NOAEL: 900 mg/kg/d		590
Ammonia 7664-41-7	0.35	76 g/m^3/2 hr 1.4–5.1 g/m^3/1 hr	Exposure: inhalation Endpoint: pulmonary function and subjective symptoms NOAEL: 6.4 mg/m^3		18
Benzene 71-43-2	3.31	10,000 ppm/7 hr	Exposure: oral Endpoint: decreased lymphocyte count *BMDL[f]: 1.2 mg/kg/d Exposure: inhalation Endpoint: decreased lymphocyte count *BMCL[g]: 8.2 mg/m^3	1	1.6
Chloroform 67-66-3	0.91–2.81	47.70 g/m^3/4 hr	Exposure: oral Endpoint: fatty cyst formation in liver and elevated SGPT[h] LOAEL: 15 mg/kg/d	2B	9.78
Dichloromethane 75-09-02	1.6–3.0		Exposure: oral Endpoint: liver toxicity NOAEL: 5.85 mg/kd/d (males) 6.47 mg/kd/d (females)	2B	87
Diethylether 60-29-7	3.56	32,000 ppm/4 hr	Exposure: oral Endpoint: depressed body weight NOAEL: 500 mg/kg/d		1,200
Ethanol 64-17-5	6.2-17.8	20,000 ppm/4 hr		1	1,900
Formic Acid 64-18-6	0.73	15 g/m^3/15 min 7.4 mg/L/4 hr			9
Hydrochloric Acid 7647-01-0	0.90	3,124 ppm/1 hr	Exposure: inhalation Endpoint: hyperplasia of nasal mucosa larynx and trachea LOAEL: 15 mg/m^3	3	C 2.8 (STEL)[i]

Substance (Including Chemical Abstracts Service [CAS] Number)	LD_{50} (g/kg bw)[a]	LC_{50}	Critical Effect Dose[b]	IARC[c] Classification	ACGIH[d] Exposure Limit (TWA)[e] mg/m^3
Methyl ethyl Ketone 78-93-3	2.9-5.5	34.5 g/m^3/4 hr	Exposure: oral Endpoint: decreased body weight LEG: 594 mg/kg/d Exposure: inhalation Endpoint: developmental Toxicity LEC: 5202 mg/m^3		147.5
Methanol 67-56-1	5.63	64,000 ppm/4 hr 87.5 mg/L/6 hr	Exposure: oral Endpoint: increased SAP[j] and SGPT[h] and decreased brain weight NOAEL: 500 mg/kg/d		260
Methylamine 74-89-5	0.08–0.69	2.9 mg/L/4 hr			6
Phosphoric acid 7664-38-2	1.53				1
Safrole 94-59-7	1.95			2B	
Sodium chromate 7775-11-3	0.01–0.05	0.03–0.12 g/m^3/4 hr			
Sodium dichromate	0.05	0.12 g/m^3/4 hr			
Sulphuric Acid 7664-93-9		347 ppm/1 hr			0.2
Toluene 108-88-3	2.6–7.5	26,700 ppm/1 hr 8,000 ppm/7hr	Exposure: oral Endpoint: increased kidney weight *BMDL[f]: 238 mg/kg/d Exposure: inhalation Endpoint: neurological effects NOAEL: 46 mg/m^3	3	75
Trichloroethane 71-55-6		24,000 ppm/1 hr 14,000 ppm/7 hr	Exposure: oral Endpoint reduced body weight BMDL10f: 2,155 mg/kg/d Exposure: inhalation Endpoint: liver histopathologic changes NOAEL: 1,553 mg/m^3	3	

[a] LD_{50} and LC_{50} values are taken from www.toxnet.nlm.nih.gov/
[b] Critical effect doses are taken from www.epa.gov/iris/
[c] International Agency for Research on Cancer
[d] American Conference of Governmental Industrial Hygienists
[e] Time weighted average

[f]Benchmark dose (lower confidence limit)
[g]Benchmark concentration (lower confidence limit)
[h]Serum glutamic pyruvic transaminase
[i]Short-term exposure limit
[j]Serum alkaline phosphatise
*Dose corresponding to a one standard deviation from the mean

+Note: This table is not a comprehensive list of all chemicals used in the manufacturing of methamphetamine and/or ecstasy, and instead is meant to summarize key health data for some of the most commonly used chemicals in the manufacturing processes of these drugs.

Appendix B: Sampling procedure for methamphetamine

This procedure describes a technique for sampling both flat and irregular surfaces for the detection and quantification of amphetamine-derived substances.

For flat surfaces, a 100 cm^2 surface is sampled by placing a 10 x 10 cm template on the area of interest and using alcohol-soaked absorbent cotton gauze to wipe the surface.

For porous surfaces, wipe sampling can only be used to verify the presence or absence of contamination rather than quantitative identification.

The following procedure can be used for collecting wipe samples:

1) Place the template in the desired position and mark the four corners with a dark marker. Remove the template and carefully place the masking tape so the defined area is within the four corners. This is defined as the sampling area.

2) To avoid cross contamination between samples, wear nitrile gloves. A new set of gloves should be used for every sample.

3) Transfer 2 to 4 mL of isopropyl alcohol to a 7.62 x 7.62 cm absorbent cotton gauze.

4) Wipe the surface according to the following procedure:

    a) Wipe the defined sampling area from left to right horizontally, top to bottom. Fold the gauze to expose a new surface;

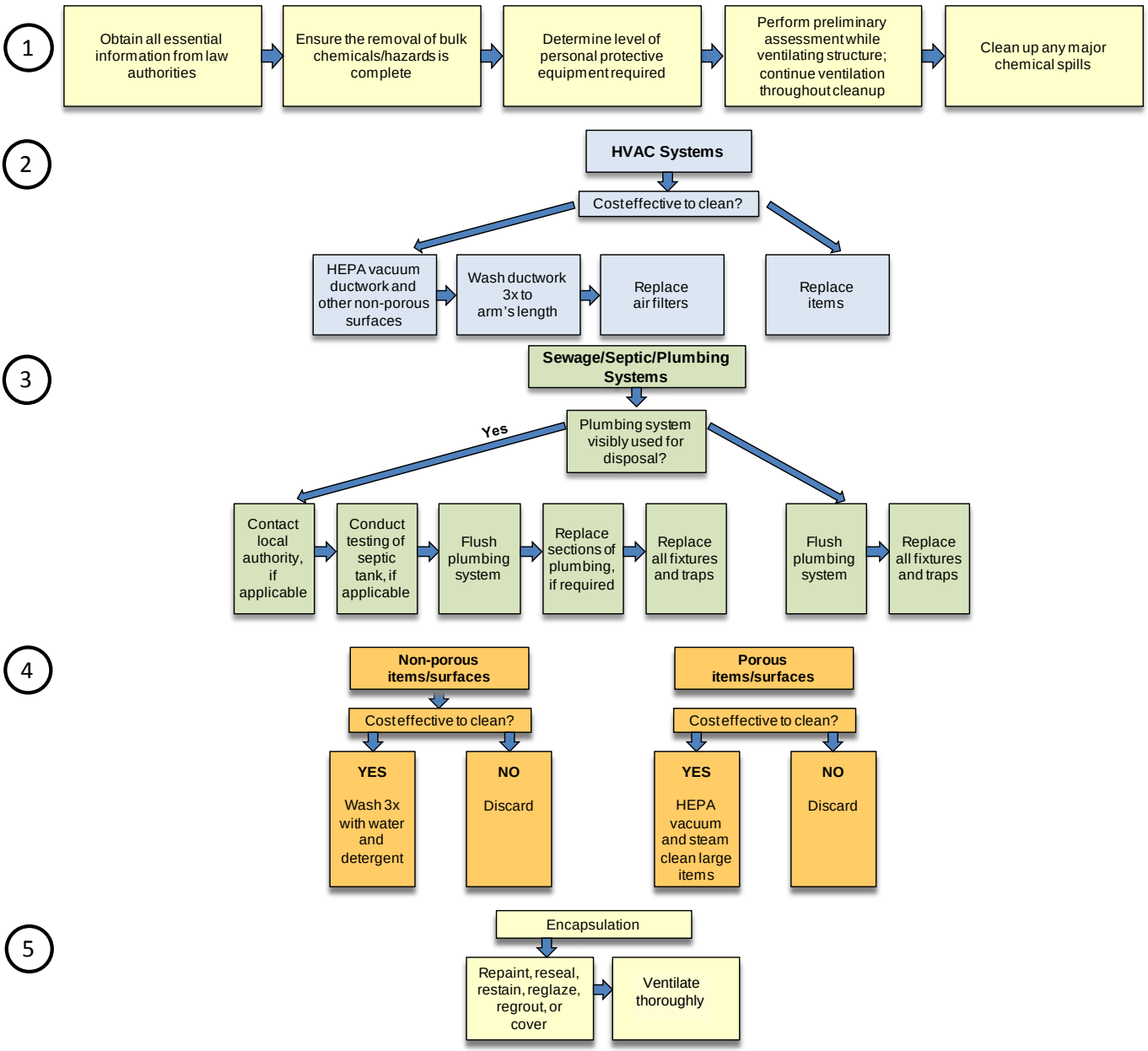
    b) Wipe the area vertically from top to bottom and fold the gauze once again to expose a new surface;

    c) Repeat step a).

5) Place the gauze into a 20 mL scintillation container and cap.

6) Document all observations pertaining to the sample and submit documents and samples to the lab.

Appendix C: Cleanup Summary



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400 East Tower
555 W 12th Avenue
Vancouver, BC V5Z 3X7
Tel.: 604-707-2445
Fax: 604-707-2444
contact@ncceh.ca

National Collaborating Centre for Environmental Health

Centre de collaboration nationale en santé environnementale

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