

Methamphetamine Contamination in Homes – Contamination and Risk Levels

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Abstract

Methamphetamine contamination has the potential to be present in residential and commercial buildings as a result of illicit manufacture and drug use, in particular smoking. The illicit manufacture of methamphetamine and the smoking of methamphetamine results in the generation and deposition of drug aerosols/residues on all surfaces, porous and non-porous. These drug residues can remain in the home for a long period of time and if they are not properly identified and cleaned this can result in unwitting exposures and adverse health effects by individuals and families who subsequently rent or purchase these properties. Research has been undertaken to better understand what levels of methamphetamine contamination remains in homes following manufacture or smoking, and what factors related to the manufacture and building design affect the spread of contamination throughout the property.

Data on contamination levels, and property observations, has been obtained from 100 homes and apartments throughout Australia to assist in better understanding the level of methamphetamine contamination that may be present. This data has been reviewed to develop a risk matrix that can be used at the start of an investigation or property assessment to determine the level of risk a property may pose to the public. The level of risk then determines the level of further investigation and remediation work that may be required to ensure the property is safe for future occupants. The risk matrix can be used by property managers including managers of public housing authorities where a significant number of illicit drug laboratories are located.

Originality – This study provides data on the level and spread of methamphetamine contamination in former clandestine drug laboratories in Australia.

Keywords methamphetamine contamination, illicit drug manufacture, risk, health effects



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1. Introduction

Illicit drugs, in particular amphetamine-type stimulants (ATS) such as methamphetamine (ACC 2011a) are manufactured in Australia within clandestine laboratories that range from crude, make-shift operations using simple processes to sophisticated operations. Clandestine laboratories are commonly located within residential homes, units, hotel rooms, backyard sheds and cars, with increasing numbers detected in Australia each year (744 laboratories detected in 2013-2014) (ACC 2015). Unlike the legal manufacture of industrial and pharmaceutical chemicals, clandestine drug operations may not involve any care in the storage, handling and disposal of chemicals and wastes nor any responsibilities in relation to health and safety during and after the cook.

The operation of clandestine methamphetamine laboratories results in the presence of a wide range of hazards and risks within the premises including the contamination of all indoor surfaces and materials with methamphetamine residues (Wright, Edwards & Walker 2016). This has the potential to expose the public to contamination that live in these premises before remediation or if no remediation is conducted. These are individuals who have not chosen to be exposed to methamphetamine, and such exposures have been associated with significant intakes of methamphetamine and adverse health effects (Wright et al. 2015). As a result it is important that the level of risk posed by these properties is understood so that appropriate measures can be implemented to manage exposures and remediate the property.

Recent guidelines are available for the assessment and remediation of former clandestine drug laboratories (Australian Guidelines on the Remediation of Clandestine Drug Laboratories)(ACC 2011b), More specifically, in relation to the assessment of these premises, these guidelines have resulted in the testing and evaluation of methamphetamine contamination levels at a number of properties across Australia. These data have been collated and reviewed with the aim of understanding the level of contamination that remains in these properties in Australia, how widespread the contamination may be, and if there are any key observations or indicators that can be used to assist in determining a preliminary view on the level of public health risk that may be posed by the property.

2. Methods

Permission was obtained from companies involved in the assessment and remediation of clandestine drug laboratories to obtain and collate data collected for the purpose of characterising contamination within former drug laboratories.

Data that characterise the level and spread of methamphetamine contamination in a premises formerly used for manufacture of methamphetamine have been obtained from the following sources:

- Data collected by companies involved in the assessment (and sometimes remediation) and validation of former clandestine drug laboratories. The data collected reflected the use of both quantitative and semi-quantitative methods.
- Data collected by the researcher using semi-quantitative methods from a limited number of former clandestine drug laboratories identified in South Australia Housing (Housing HA) properties. Flinders University has an established Memorandum of Understanding (MoU) in relation to the testing of former clandestine drug laboratories in Housing SA premises. Where former clandestine drug laboratories were identified during the research period these premises were sampled using a semi-quantitative method.

Quantitative methods involved laboratory analysis to provide precise levels of methamphetamine residues on the surface sampled. All quantitative results were obtained from commercial laboratories using GC-MS methods, with analytical limits of reporting typically in the range of 0.02 to 0.5 $\mu\text{g}/100\text{ cm}^2$.

Semi-quantitative sampling involved the use of an immunoassay sampling method. The method adopted was developed by the U.S. National Institute for Occupational Safety and Health (NIOSH) to identify the presence of methamphetamine residues on surfaces at or above a particular level. The sampling test kits, MethChek, are available from SKC Incorporated (SKC) and can be used to detect the presence of methamphetamine at 0.05, 0.1, 0.5 or 1.5 $\mu\text{g}/100\text{ cm}^2$. The accuracy of the MethChek tests was reported to be $\geq 97\%$ within $\pm 20\%$ of the method cut-off, with no false positives were reported. In relation to cross-reactivity, MDMA is 100% cross-reactive with MethChek. Other drugs of abuse and methamphetamine precursors are reported to be less than 10% reactive. No known negative interferences have been reported (SKC 2015).

Where collected, other data relevant to contamination that may remain in former drug laboratories such as total volatile organic compounds (VOCs, typically reported using a photoionization detector), pH, presence of inorganics (such as lead, mercury, iodine and phosphorous measured using an X-ray fluorescence instrument) and the use of iodine swabs was also collected. While this data is useful in understanding the nature of contamination in these premises, less than one third of the properties evaluated included at least one of these other tests.

Only data obtained from premises known, or suspected, to have been involved in the manufacture of methamphetamine have been included in this study. The data obtained has been de-identified so that the address and property owner cannot be linked with, or inferred from the data.

Where available, additional information about the premises and specific observations relevant to the manufacture of methamphetamine and characteristics of the property that may enhance or restrict the spread of contamination was obtained. This information related to the following:

- the likely method of manufacture;
- likely location of manufacture;
- type of building (including whether it was privately owned or public housing);
- characteristics of the property that may either assist or prevent the spread of contamination in the premises;
- type of sampling undertaken, sampling and analytical methods;
- location of samples;
- any other chemicals detected;
- results of any preliminary testing; and
- results of any testing undertaken outside in soil and/or septic systems.

It is noted that the methods used by different companies for the assessment of contamination at different premises varies. Some of the data has come from semi-quantitative immune-assay tests, while other data was quantitative (based on laboratory analysis using standard methods). In addition not all investigators report details about the property (with none of the reports providing details on whether the property is open-plan or has isolated rooms) or other observations that may be relevant to this study. The information provided was not consistent between the different companies who provided access to the data, or within the companies themselves as techniques were observed to change/refine over time. Specifically assessment techniques and data collected was different before and after the release of the Australian guidelines on assessing and remediating clandestine drug laboratories in 2011 (ACC 2011b). Hence the information and data considered in this study, derived from these companies, is limited by the methods adopted and the information provided by each company for each individual property.

3. Results

3.1 Properties included in the study

Data have been obtained from 100 individual premises in Australia. The data obtained are derived from 5 states in Australia: New South Wales (25 premises); Victoria (18 premises); Queensland (3

premises), South Australia (20 premises) and Western Australia (34 premises). No sites were obtained from Tasmania, The Northern Territory or the Australian Capital Territory.

The majority (88%) of the properties were located in urban areas, with these equally split between privately owned properties and public housing. Rural and semi-rural properties accounted for 10% of the properties evaluated, with the remaining 2% comprising mobile caravans. No commercial premises were included in this study.

Of the properties included in this study the majority were low-density residential homes (58%, which were mostly single storey homes), units (36%) and townhouses (6%).

3.2 Manufacture methods and location

The information available in relation to each of the properties included in this study did not always provide specific information (such as that from a police report) in relation to the manufacturing method likely to have been used to manufacture methamphetamine. In some cases information was available on the range of chemicals and equipment seized by police, observations from inspections (such as iodine staining) and preliminary screening data (such as the detection of iodine and phosphorus on surfaces) from which the manufacturing method could be inferred. For data collected from South Australia, these were assumed to all be derived from the hypophosphorous method (which is the most common method in South Australia (ACC 2015)). For data collected from Western Australia, information was cross checked with details held by the Western Australian Department of Health as to whether the method was the Nazi/Birch method or a non-Birch method. Overall the most common method of manufacture was the hypophosphorous method (55%) followed by the Nazi/Birch method (35%). Other methods included the red-phosphorous method (5%) and other methods (likely P2P) (5%).

Table 1 presents a summary of the distribution of manufacturing methods between states relevant to the properties included in this study. The manufacturing methods relevant to these premises are consistent with those reported in the national statistics (ACC 2014, 2015), with the use of the Nazi/Birch method predominantly reported in Western Australia and the hypophosphorous and red-phosphorous methods predominantly reported in the eastern states. The other methods (likely to be the P2P method) were all reported from NSW.

In relation to the location of manufacture at the property, the available data are limited to information provided on police reports. Sometimes this information identified the location (or locations) of manufacture however in a number of cases the specific location is not known but the location of where chemicals and equipment are found are noted. In these situations a number of locations may be possible and are reported. For a number of other properties limited information is available on the likely location of manufacture, however observations provided during the preliminary assessment provide additional information on the likely location of manufacture. Figure 1 presents a summary of the available information on the location of manufacture (some sites had more than one location so total is greater than 100%). Where reported, the most common locations for manufacture are the kitchen and shed/garage.

Table 1: Contamination Data: Manufacturing Methods by State

State	Proportion of Laboratories Known or Suspected to use Manufacture Method in this Study			
	Nazi/Birch	Hypophosphorous	Red P	Other (P2P)
Western Australia	94%		6%	
South Australia		100%		
Victoria	11%	89%		
New South Wales		60%	20%	20%
Queensland*	33%	66%		

* Note that a limited number of premises were included from Queensland (3 in total) affecting the reliability of this distribution

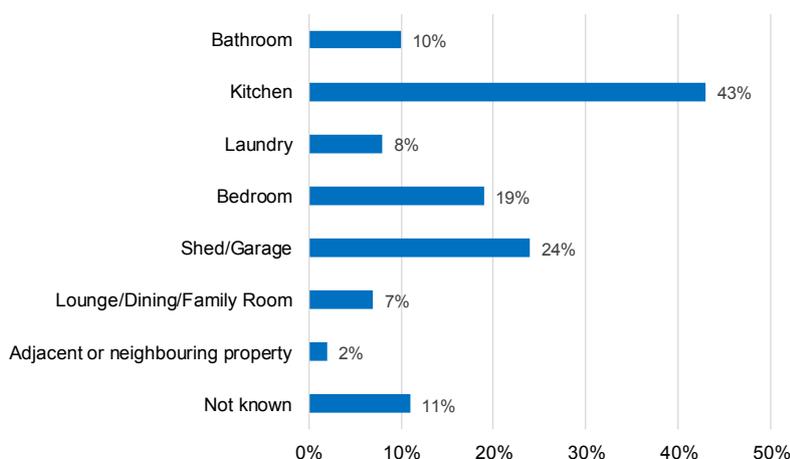


Figure 1: Likely Location of Manufacture

3.3 Methamphetamine residue levels on surfaces

Surface residue samples obtained in this study were collected from a wide range of locations, depending on the location of manufacture and chemical storages, presence of staining, layout of the premises and results of preliminary testing (where undertaken). The number of samples collected in each premises varied significantly.

Methamphetamine surface residues were reported in 99 of the 100 premises included in this study. The one premises where indoor surface residues were not collected only involved the sampling of contamination outdoors. Of these premises, 36 have been characterised on the basis of semi-quantitative methods, with the remaining 63 properties characterised using laboratory analysis using GC-MS methods. For these premises a code was allocated that relates to the state in Australia where the property is located, whether the property is a house (H) or unit (U) and a unique number.

Figure 2 presents a summary of the range of concentrations reported at each of the premises where methamphetamine surface residues have been reported indoors or surfaces, grouped by the reported method of manufacture. The figure has combined both quantitative data as well as semi-quantitative data. The semi-quantitative data includes data that indicates surface residue levels are either less than a test reporting limit, greater than a test reporting limit or within a range of test reporting limits. For different areas within the premises evaluated, Table 2 presents a summary of the range of concentrations reported.

4. Discussion

4.1 General

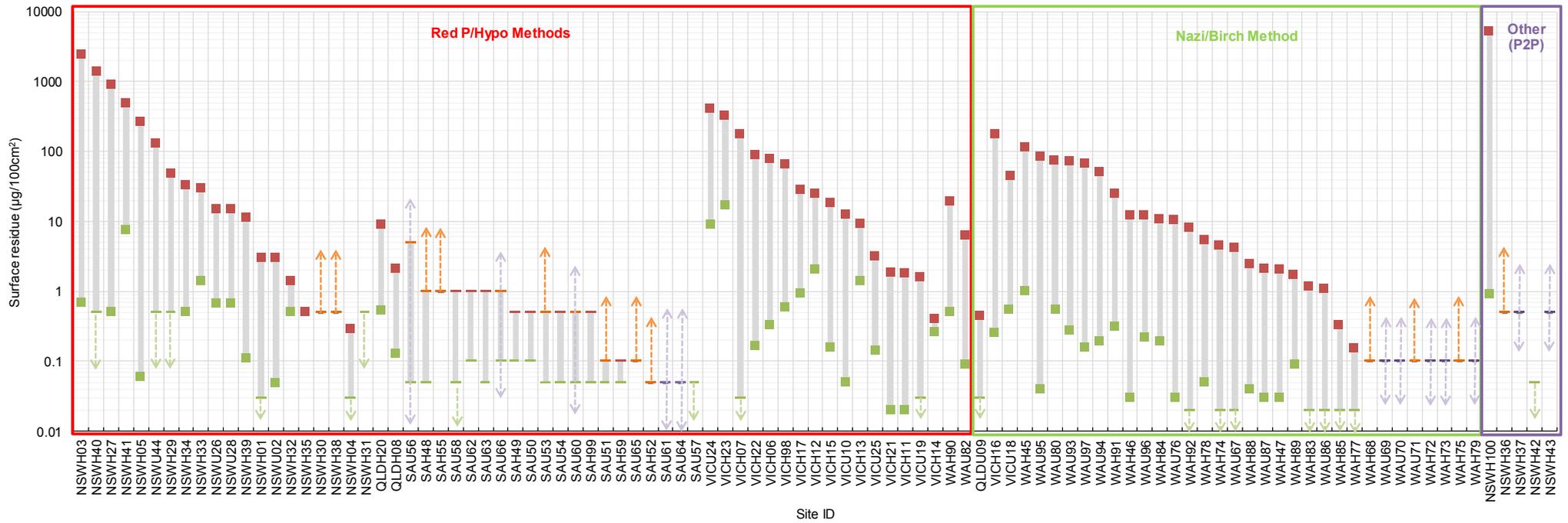
As the data collected in this study were obtained from a range of different sources they are highly dependent on the sampling locations, sampling protocols, analysis methods and subjective and variable observations adopted and reported by each company, and individuals within these companies. This has resulted in a data set that is of mixed quality. However the data are suitable for the purpose of evaluating whether properties formerly used for the manufacture of methamphetamine remain contaminated with methamphetamine, whether the level of contamination could be characterised as low, medium or high and whether the data indicate the contamination has spread throughout the home.

4.2 Level and extent of methamphetamine residues

The range of methamphetamine surface residues reported in homes evaluated in Australia are generally consistent with the range reported in former drug laboratories and homes used for controlled cooks in the US (Wright, Edwards & Walker 2016). Some higher residue levels of contamination have been reported in former clandestine drug laboratories in the US, however these higher levels were reported from stained areas on ceilings and inside microwave ovens (used for cooking), neither of which were evaluated in any of the Australian premises included in this study.

When reviewing the range of concentrations reported inside premises in Australia, it should be noted that the criteria methamphetamine residues on surfaces in residential homes is $0.5 \mu\text{g}/100 \text{ cm}^2$ (ACC 2011b). This is health-based criteria, below which contamination levels on surfaces in residential homes were considered (in the ACC 2011b guidelines) to be acceptable and suitable for habitation. Housing SA assessments utilise semi-quantitative MethChek kits with a detection limit of $0.05 \mu\text{g}/100 \text{ cm}^2$ and adopt an action level, for remediation, of $0.1 \mu\text{g}/100 \text{ cm}^2$.

The highest levels reported from all the premises tested was within the air conditioning ducting and kitchen range hoods. Contamination in air conditioning ducts and ventilation systems have the potential to result in the ongoing movement or re-distribution of contamination throughout a home. Such mechanisms are of importance for understanding the spread of contamination and providing information that may be relevant to the assessment of inhalation exposures that may occur in premises where contamination is not remediated.



- Maximum quantitative level reported (laboratory analysis)
- Minimum quantitative level reported (laboratory analysis)
- Upper limit reported from immunoassay testing (values may be less than this)
- Lower limit reported from immunoassay testing (values may be higher than this unless indicated otherwise)
- ↕ Semi-quantitative immunoassay data only
Data reported as > LOR
- ↕ Not detected at the lowest LOR
- ↕ Semi-quantitative immunoassay data only
Mixed data set comprising <LOR and >LOR, with the LOR varying for some sites

Figure 2: Range of methamphetamine surface residues reported indoors at each premises

Table 2: Summary of Methamphetamine Surface Residues on Hard Surfaces in Homes

Location/Activity	Range of Maximum Methamphetamine Surface Residue Reported ($\mu\text{g}/100\text{ cm}^2$)
<u>Walls and surfaces within:</u>	
kitchen including benches	0.05 to 791
dining/family room	0.03 to 460
lounge room	0.02 to 179
bedrooms	0.02 to 260
bathrooms	0.03 to 320
entrance hall/foyer	0.03 to 27.7
study/sun-room	0.05 to 100
laundry	0.03 to 65
upstairs (ground floor used for manufacture)	0.09 to 71
shed/garage	0.04 to 1400
Ventilation and fans (including kitchen range hood)	0.13 to 5171
Kitchen Appliances (microwaves, burners, ovens, refrigerators)	0.25 to 180
Roof space	0.2 to 12.8
Neighbouring unit or house (not used for manufacture)	0.14 to 3.1 (<1% maximum in unit used for manufacture)

It is noted that data summarised in Figure 2 and Table 2 includes a number of properties and areas where the range of methamphetamine surface residues varies significantly, in some cases by five orders of magnitude or a factor of 10,000. This reflects the highly individual nature and spread of contamination that is present in each of the properties. The potential for significant variability in surface residue levels in a property should be considered when conducting a preliminary evaluation of potential contamination and in the design of more detailed sampling plans.

Further review of the data collected indicates that where the location of manufacture was known, samples from these areas showed the highest level of methamphetamine contamination. However it is noted that in some cases the information on the potential location of manufacture was not available or potentially not well understood. Hence knowledge or guidance in relation to the likely location of manufacture is valuable in directing testing for contamination in a property.

In relation to the potential spread of contamination within a premises the available data is limited by the information available on the location of manufacture and the number and location of samples collected in each premises, which varied depending on the size of the property and the professional collecting the samples. As there is no consistent sampling protocol followed by each of the investigators who collected the samples, the data set is of mixed quality. In addition the reporting of the manufacture location is dependent on information provided by police when the premises was seized. Most of the laboratories seized are not active laboratories and hence the information provided typically relates to the location of chemicals and equipment, with some information also provided on potential manufacture location based on powder residues and stains/burns. Review of the quantitative data indicates that the potential location of manufacture reported does not always correlate with the location where maximum surface residues are reported.

Based on the data obtained 83% of the properties evaluated reported some level of spread of contamination throughout a home and 58% of the properties evaluated reported wide-spread movement of contamination in the home.

Based on information and data collected and presented in this research, and literature, the following factors have been identified that affect the level and spread of contamination in a home, which then affects the level of risk posed by a property and the approach adopted to remediate the property:

- The method of manufacture is important as contamination from laboratories using the Nazi/Birch reduction method are typically lower than for other methods (confirmed from the assessment and residue data from former drug laboratories).
- The scale of the manufacture is important as the manufacture of large quantities of drug, regardless of the method has the potential to result in higher levels of contamination (WA Health 2012).
- Closing up the home to prevent detection contains contamination in the building. While it has been reported that an open plan home is more likely to be associated with the spread of contamination, compared with homes with isolated rooms (Hammon & Griffin 2007; Light 2009; Patrick, Daniell & Treser 2009), this could not be confirmed in this study as the layout of homes where data was available was not provided.
- The most common places for cooking methamphetamine was in a shed/garage or inside the home, in the kitchen, bathroom or bedroom.
- Use of ventilation systems inside the home which are a common method for removing gases during the cook, resulted in the spread of contamination in a home. The observations reported in this study are consistent with published data (McKenzie 2014).
- Fire and explosion results in elevated levels of contamination. This observation is consistent with data from premises evaluated in the US (Martyny et al. 2007).
- Observation of burns, stains and powder residues are associated with widespread contamination in the property. This is likely to reflect that little care was taken during the cook, which may have resulted in the spread of contamination.

Where preliminary data is collected in a property, the following were identified as those that provided good indicators on the presence of methamphetamine contamination in a premises:

- Preliminary/screening testing for methamphetamine residues using an immune-assay test (targeted at the likely location of manufacture) have provided a confirmation of the presence and, in some cases, the spread of contamination. This has been identified as a key preliminary assessment technique in another study (Light 2009).
- Elevated levels of total VOCs as reported using a PID were associated with elevated levels of contamination in the property. This is identified as a key preliminary assessment technique in another study (Light 2009).
- pH levels are indicative of the presence or use of acids and alkalis. While not found to be a unique indicator of the presence of contamination evidence of acids and alkali spills suggests little care was taken during the cook, which may have resulted in the spread of contamination.

4.3 Risk Matrix

The characteristics and parameters identified in this study, and other published studies as summarised above, can be used in the development of a preliminary risk assessment tool to enable moderate to high level risk premises to be identified separately from low level risk premises. The level of assessment and remediation required to address these categories of premises is expected to be different.

A risk scoring system/risk matrix enables a score to be calculated that is based on information that may be obtained from the Police report and/or a preliminary site inspection. The matrix can be used by housing officers from state housing authorities or individuals undertaken a preliminary site inspection (that may include Environmental Health Officers [EHOs] or consultants engaged by EHOs). Any preliminary investigation should be undertaken with appropriate PPE.

The risk matrix aims to categorise premises based on the potential for a low, medium or high risk of methamphetamine contamination within the property. The level of risk is based on the potential for the presence of methamphetamine residues to exceed the health-based criteria of 0.5 µg/100

cm² for residential homes (ACC 2011b), and the potential for the contamination to be spread throughout the premises. The risk matrix considers and scores the following aspects:

- Information from the Police report, where available, that includes the drug manufactured, the manufacture method determined directly from the police report or the chemicals reported to be found and removed from the premises and the size of the lab. Where details on these aspects are not available the default position should be to allocate a higher level score, consistent with elevating the level of risk relevant to the property.
- Information that can be obtained from property observations including evidence of staining, burns, scorch marks and powder residues, the presence of air conditioning, presence of room ventilation and the overall cleanliness (or not) of the property.
- Information that can be obtained from preliminary tests including the semi-quantitative surface test, pH test from locations where manufacture is suspected or there are stains present and a screen of VOCs in air using a PID.

5. Conclusions

Data collected from the assessment of former clandestine drug laboratories, for the purpose of remediation, provides a valuable insight into the levels and spread of methamphetamine contamination that remains inside premises in Australia. The available data indicates that premises used for the manufacture of methamphetamine have variable levels of contamination. However there are a significant number of premises where the methamphetamine contamination is present at levels that exceed the current guidelines for residential use. Review of the data and other information collected in this assessment has identified key information and observations that can be used to distinguish between low and high risk properties in relation to the level and spread of contamination. Data obtained from a police report, property observations and preliminary tests can be used to rank potential risks a property poses to public health. This may be undertaken using a risk matrix approach. This is important as the level of assessment and remediation required to ensure these properties are safe for future occupants will differ depending on the level of risk posed.

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