Exposure and Risk Associated with Clandestine Amphetamine-Type Stimulant Drug Laboratories

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CONTENTS

SUMMARY

Illicit drugs such as amphetamine-type stimulants, and more specifically methamphetamine, are manufactured in Australia within clandestine laboratories that range from crude, makeshift operations using simple processes to sophisticated operations. The manufacture of methamphetamine if commonly undertaken in residential homes located in urban and rural areas and is known to be associated with a wide range of hazards derived from the chemicals used in manufacture, gases produced during manufacture, drugs and drug residues as well as wastes. This research project has been undertaken to obtain environmental and biological data to better understand and characterise potential exposures and long-term health risks that may occur as a result of clandestine manufacture of methamphetamine within residential homes in Australia.

Information and data have been collected from interviews conducted with individuals convicted of the manufacture of methamphetamine as well as Police and forensic investigators involved in the detection and assessment of these drug laboratories; characterisation of environmental contamination levels in properties formerly used for the manufacture of methamphetamine; and a number of case-studies where co-located environmental contamination, biological and health data have been obtained from individuals inadvertently exposed to contamination from former drug manufacturing.

These data comprise a mix of qualitative and quantitative data that provide consistent evidence of the following:

- Activities and behaviours associated with the clandestine manufacture of methamphetamine results in the contamination of surfaces and possessions inside properties, as well as outdoors from the disposal of waste.
- The level and spread of contamination can vary significantly within individual properties, based on a wide range of factors associated with the manufacture and the property. However there is the potential for the level of contamination to be significantly elevated above current guideline levels.
- The manufacture of methamphetamine, and exposure to contamination that remain within a former drug laboratory have the potential to result in a range adverse health effects.
- Police and forensic investigators understand the potential for exposure and health effects when entering methamphetamine drug laboratories and have procedures to minimise exposure. For the participants involved in this study, and the time period of exposure evaluated, these procedures are preventing exposures to methamphetamine.
- For the general public who may be inadvertently exposed to contamination in former methamphetamine drug laboratories in properties purchased or rented, there is the potential for significant levels of exposure and intake of methamphetamine, particularly for

young children. Exposures that have occurred in these situations have resulted in adverse health effects in the families evaluated in this study.

Based on the information and data evaluated in this research, the current understanding of potential risks to the public posed by these properties appears to be underestimated. These risks are further enhanced by difficulties in the detection of, and the effective assessment and remediation of former clandestine drug laboratories in various jurisdictions in Australia.

The data collected in this research has been used to develop a risk matrix to determine the level of risk posed to the community by a former clandestine drug laboratory which can help direct the appropriate level of assessment and remediation.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: 

Date: 25 July 2016

DEDICATION

This thesis is dedicated to my husband Michael and children, Toni, Megan and Alex. Thank you for the endless love, support and patience with the many frustrations and challenges of this work.

I also want to thank my parents who have taught me that you never stop learning and you can follow and achieve your passions at any time in your life.

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LIST OF ABBREVIATIONS

AC	Air-conditioning
ACC	Australian Crime Commission
AMP	Amphetamine
ATS	Amphetamine-type stimulants
BASC	Behaviour Assessment System for Children
cm	centimetre
^{o}C	Degrees Celsius
DMT	N,N-dimethyltryptamine
DSM	Diagnostic and Statistical Manual of Mental Disorders
EHO	Environmental Health Officer
EPH	Ephedrine
ESI	Electrospray ionisation
g	gram
GC	Gas chromatograph
GHB	Gamma hydroxybutyrate
Hypo	Hypophosphorous
kg	kilogram
LC	Liquid chromatography
LOR	Limit of reporting
MA	Methamphetamine
MA:AMP	Methamphetamine to amphetamine ratio
MDA	3,4-methylenedioxyamphetamine
MDMA	3,4-methylenedioxymethamphetamine (“ecstasy”)
mg	milligram
mm	millimetre
MoU	Memorandum of understanding
MS	Mass spectrometry
nd	Not detected
ng	nanogram
NIOSH	National Institute for Occupational Safety and Health
NSW	New South Wales
P2P	Phenyl-2-propanone
PID	Photo-ionisation detector
pg	picogram
PPE	Personal protective equipment
ppb	Parts per billion
ppm	Parts per million
PRS	Parent Rating Scales
PSE	Pseudoephedrine
Qld	Queensland
REC	Research and Evaluation Committee
Red P	Red phosphorous
SA	South Australia
S/P	Saliva-plasma ratio
µg	microgram
µL	microlitre
US	United States
Vic	Victoria
VOCs	Volatile organic compounds
WA	Western Australia
XRF	X-ray fluorescence

PART A: BACKGROUND AND REVIEW

1.0 INTRODUCTION

Illicit drugs, in particular amphetamine-type stimulants (ATS) (1) are manufactured in Australia within clandestine laboratories that range from crude, makeshift operations using simple processes to sophisticated operations. These laboratories use a range of chemical precursors to manufacture or "cook" ATS that include methylamphetamine, more commonly referred to as methamphetamine ("ice"), and 3,4-methylenedioxymethamphetamine (MDMA or "ecstasy"). 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) (2). Unlike the legal manufacture of industrial and pharmaceutical chemicals, clandestine drug operations typically do 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. Many of these laboratories are within urban communities where there are significant hazards (including chemical exposures) to cooks, other residents, neighbours, law enforcement and other first responders and the general public who may visit or reoccupy the premises.

Environmental exposures to illicit ATS drugs and chemicals used to manufacture them are not well defined, particularly for children. From its initial establishment through its ultimate re-occupancy, a clandestine drug laboratory typically goes through a number of phases where there is the potential for environmental exposures to the manufactured drug and a wide range of chemicals associated with the manufacture of these drugs. These phases include (3):

- An operational phase, where there is the potential for exposure to a large number of chemicals including the manufactured drug;
- A discovery phase, where the lab is "seized" by police and bulk chemicals and equipment are removed. Residents may remain on the premises, or move back in immediately after police have completed their investigations, and be exposed to a wide range of chemicals that remain in the premises; and
- A post operation/ discovery/ remediation phase, where exposures may occur in a premises that may have been formerly used for the manufacture of illicit drugs. Exposures in these premises may be associated with a former laboratory that was undetected (so not remediated); was a known laboratory but not remediated; or was a known laboratory that has not been adequately remediated. In these premises exposure to contamination can occur from chemical and drug residues inside and from dumped waste materials outside. These contaminants can persist for a long period of time and result in risks to human health and the environment (4-6).

The greatest potential for exposure occurs during the operational phase where the inhalation of airborne contaminants (including the ATS [such as methamphetamine] and gases that include acidic, corrosive and toxic gases) and direct contact with primary chemicals, wastes and drug products are expected to represent the greatest hazard, along with physical hazards associated with the use and manufacture of chemicals that are flammable, reactive and potentially explosive (7, 8). The manufacture of ATS places several groups of people at risk including adults (such as the drug "cooks"), children, neighbours, police, forensic scientists and emergency workers (7, 9-11). Children living in proximity to clandestine laboratories operated by parents or family members are at increased risk of injury and adverse health effects (9, 12).

In relation to the assessment and remediation of contamination derived from the operation of an ATS laboratory, Australia has developed guidelines (3, 13) that include human health risk-based guidelines for indoor air, indoor surfaces and outdoor environments in residential, commercial and public open space areas (3). These guidelines provide guidance on the physical assessment and remediation of property/premises formerly used for the manufacture of ATS. However there is limited guidance on assessing and managing individual exposures. In particular, understanding and managing exposures and health risks by individuals (particularly children) during the operation of the laboratory, immediately after seizure or if the property is not remediated and is re-occupied is limited.

In Australia, the *Law and Justice Legislation Amendment (Serious Drug Offences and Other Measures) Act 2005* (the SDO Act (14)) includes offences (that carry custodial sentences) which involve endangering children during activities associated with the manufacture of controlled drugs or precursors. Most Australian state legislation and initiatives focus on penalties and harm reduction measures associated with drug use, possession and trafficking, with some provisions for offences that relate to manufacture, or equipment or precursors used for manufacture of drugs (7). One state, Western Australia, has introduced stronger legislation that specifically provides a minimum term of 12 months of imprisonment for anyone who causes harm to a child through the manufacture of drugs (15). Outside of criminal offences specifically related to harm caused during the manufacture of an illegal drug, the laws that relate to the protection of the health of the general public who may be exposed to contamination in a former ATS drug laboratory are enforced by local authorities including Councils (13, 16, 17), and typically relate to "nuisance" issues or premises not being in a safe or healthy condition (e.g. NSW Local Government Act 1993, Western Australian Health Act 2011, Victorian Public Health & Wellbeing Act 2008 and South Australian Public Health Act 2011). These legislation (and others) generally provide limited powers to prevent a property being re-occupied prior to remediation.

Ultimately it is the role of the property owner to ensure their property is suitable for occupation. In relation to rental properties legislation is available in various states that require a landlord provides

residential premises that are clean and fit for habitation (e.g. NSW Residential Tenancies Act 2010, Victorian Residential Tenancies Act 1997, Queensland Residential Tenancies and Rooming Accommodation Act 2008 and South Australian Residential Tenancies Act 1995). Similarly such legislation also typically states that the tenant must not use the premises for any illegal activity or purpose.

This research has been undertaken to obtain data and information to better understand and characterise exposures and health effects that may occur to individuals who may reside in premises where ATS have been manufactured or used, as detailed in **Section 4**.

2.0 BACKGROUND INFORMATION ON ISSUES ASSOCIATED WITH ATS DRUG LABORATORIES IN AUSTRALIA

2.1 General

ATS are a group of psychostimulant drugs that are related to the parent compound, amphetamine, and have a wide range of common/street names (18). The manufacture of ATS, specifically methamphetamine, involves a relatively simple chemical processes that use highly flammable, very toxic and corrosive chemicals (7). The first clandestine ATS laboratories were found in San Francisco and the surrounding Bay area around 1962 with the first Australian clandestine ATS laboratory reported to be in Sydney in 1976 (19). The number of clandestine drug laboratories detected in Australia have continued to increase over the past decade, as illustrated in **Figure 1**. It is estimated that approximately only 1 in 10 laboratories are detected in Australia (20). The number may be higher than this as data from New Zealand indicates that 32% of frequent drug users in 2011 indicated that they cooked (or had an attempt at cooking) their own drugs (21).

The internet has been identified as playing an increasing role in the development of local methamphetamine production due to the increased ease of access to chemical precursors, equipment and information (9). Scales of clandestine drug manufacture range from easily transportable small-scale 'boot labs' (so-called because they can literally fit into the boot of a car for easy transportation) and smaller addict-based laboratories to more permanent large-scale laboratories (22) with the distribution of different sized laboratories detected in 2013-14 illustrated in **Figure 2**.

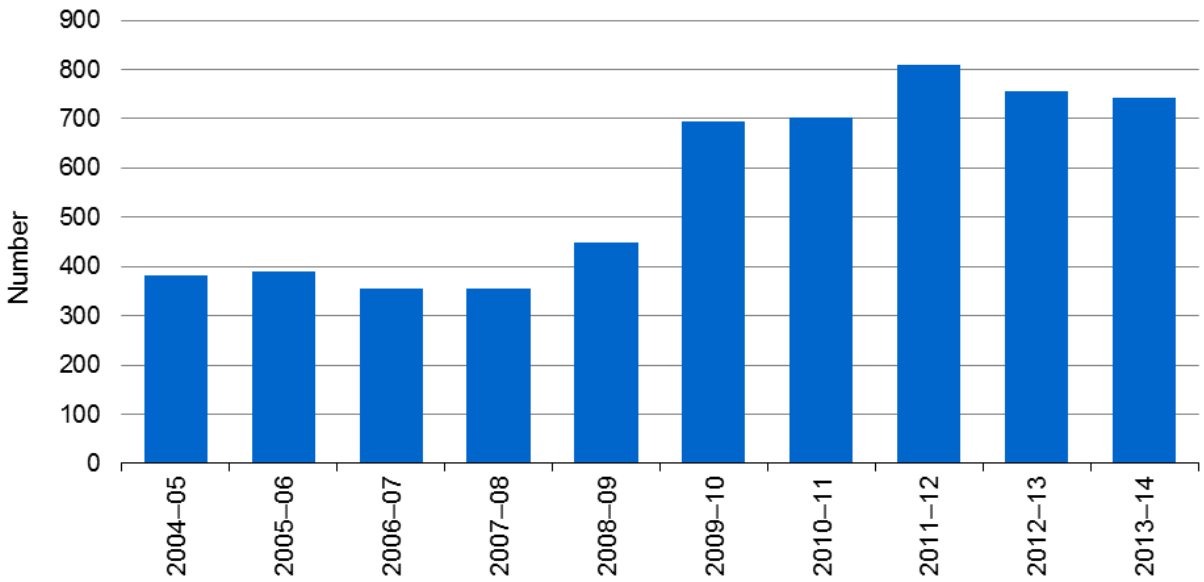


Figure 1 **Number of Clandestine Drug Laboratory Detections in Australia: 2005/05 to 2013/14 (2)**

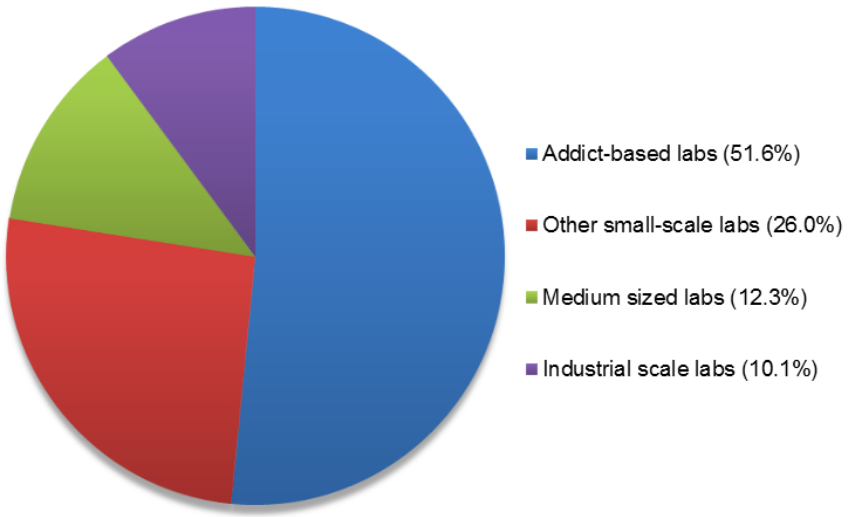
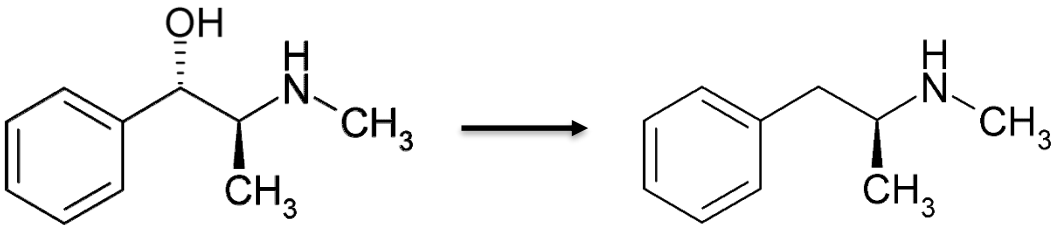


Figure 2 **Size and Production Capacity of Clandestine Drug Laboratories Detected in Australia in 2013/2014 (2)**

From 2008 to 2013 between 68% and 71% of the clandestine laboratories in Australia were detected in residential areas with the rest from commercial/industrial, rural areas and vehicles (1, 2, 18, 23-25). The increasing detection rate of clandestine laboratories, particularly in urban residential areas in Australia, has resulted in an increase in media reports, particularly in relation to injuries and public risks associated with explosions, exposures by police during seizures, the presence of children at these premises and general community concerns.

2.2 Drugs Manufactured and Common Methods

Since the late 1970's over 100 "recipes" or methods used to manufacture ATS have been identified in information provided by the Australian Crime Commission (3) in support of the national Clandestine Drug Laboratory Remediation Guidelines (13). Of the clandestine laboratories detected in 2013-2014 (2) 78.9% were associated with the manufacture of ATS with <1% associated with the extraction of precursor chemicals pseudoephedrine and ephedrine. Of the ATS laboratories seized, the majority (99%) were associated with the manufacture of methamphetamine and amphetamine, with the remaining 1% associated with the production of MDMA (3,4-methylenedioxymethlamphetamine, also known as "ecstasy"). Pseudoephedrine is the preferred primary precursor for the manufacture of methamphetamine due to the ease of conversion (20), where the reaction required involves the removal of a single hydroxyl group from the pseudoephedrine molecule to produce methamphetamine (refer to **Figure 3**) (20).



pseudoephedrine methamphetamine

Figure 3 Reduction of pseudoephedrine to methamphetamine

There are four main methods that have been identified in Australian in relation to the manufacture of methamphetamine (1-3, 7, 19, 23-25):

- Hypophosphorous (or Hypo) method (which is a variation of the red phosphorous method) where ephedrine or pseudoephedrine, iodine and hypophosphorous acid are used. This is the most common method of methamphetamine manufacture in Australia accounting for approximately 63% of identified ATS laboratories in 2013-14, primarily in the eastern states (2, 20).
- Ammonia (“Birch” or “Nazi”) method where ephedrine or pseudoephedrine is reduced in a chemical process involving anhydrous ammonia and lithium or sodium metal. Despite the hazards associated with this method, it is quick and efficient (20) and accounts for approximately 21% of the identified ATS laboratories in 2013-14, principally in Western Australia (2, 18).
- Red phosphorous (or Red P method) method where ephedrine or pseudoephedrine is reduced using red phosphorous (extracted from match box striker plates) and hydriodic acid. This method accounted for approximately 7% of identified ATS laboratories in 2013-14, primarily in the eastern states (2).
- Phenyl-2-propanone (P2P) method (not common in Australia), using either the Leuckart method or the “Hells Angels’” method where P2P is reduced using formamide, ammonium formate, formic acid, methylamine, mercuric chloride, aluminium foil and methanol. This method accounted for approximately 4.5% of identified ATS laboratories in 2013-14, primarily in the eastern states (2).

2.3 Activities that Give Rise to Contamination and Exposure Pathways

During the manufacture of methamphetamine, a range of chemicals are used as precursors, produced as by-products, and drug products have the potential to be present in air as volatiles[1] or gases, remain or deposit to surfaces within the home or be present in liquid waste that may be dumped down drains, stored in various containers indoors or dumped outside (to soil or water) (3). There are many general reviews that identify a range of chemical hazards associated with the manufacture of methamphetamine that include the use of corrosive, explosive, flammable and toxic chemicals (5, 12, 26-32).

More generally, the manufacturing of methamphetamine from ephedrine and pseudoephedrine (most common and preferred method in Australia) has the potential to result in contamination from the storage and use of precursors and chemicals, gases released during various stages of manufacture, methamphetamine residues and waste materials.

Use and storage of precursors and chemicals: The manufacture of methamphetamine requires the collection (often illegal (33)) and storage a range of products and chemicals used as precursors to the manufacturing process. These products include (1) cold and allergy medications, drain cleaner, rock salt, battery acid, lithium batteries, pool chloride, iodine, lighter fluid, matches, fireworks, distress flares, antifreeze, propane and paint thinner. Waste materials generated during the manufacture can also be stored within the premises. Given the illegal nature of the drug manufacturing process these chemicals are often stored in unlabelled containers and unsuitable containers (including containers with no lids or food containers) that result in accidental ingestion (34) or leaks and spills; or dumped into drains, soil or waterways (29, 35). Precursor chemicals have been found to be present at high concentrations in kitchen appliances such as microwaves (36), where contamination of other food items prepared in these areas can occur. For example, methamphetamine has been detected in chicken removed from a refrigerator where it was adjacent to methamphetamine in solution in a jar (37).

Chemicals used in the manufacture of methamphetamine include solvents that are volatile (8, 27, 34) that, when used in an enclosed space results in direct irritation, inhalation exposures and systemic absorption.

Gases released during manufacture: Cooks using the ammonia method (more common method in the United States), readily produce ammonia gas (38). Cooks using the red phosphorous and hypophosphorous methods (more common in Australia) produce phosphine gas (39). Both of these gases are toxic and in an enclosed space, concentrations in air have the potential to be high resulting in direct irritation and inhalation exposures/systemic absorption and injuries (40, 41).

[1] Volatile, as referred to in this research, refers to chemicals that easily evaporate at room temperature, and is expected to be present in the air where inhalation exposures may occur.

Phosphine in particular has poor odour warning properties and unwitting fatal exposures have been reported (42). Hence bystanders and neighbours may recognise some ‘chemical odours’ such as pungent ammonia yet may not notice other more harmful gases or vapours.

Gases that are produced during the cooking process are absorbed into porous materials and may be released back into the air (off-gas) over time resulting in inhalation exposures for a period of time after the cook has been completed. Limited data is available on this off-gasing process or the length of time over which it may occur and be significant with respect to exposure and health risks.

Release of iodine residues: Iodine is released (27) during the manufacturing process (red phosphorous and hypophosphorous methods) and forms a surface residue that often stains the walls of a room where the drug was manufactured. These surface residues can result in exposures via dermal absorption and ingestion following transfer to hands and objects.

Methamphetamine residues: Methamphetamine is generally produced as the free base (methamphetamine base) or the hydrochloride salt (methamphetamine hydrochloride). Methamphetamine base is an insoluble oil at room temperature and is the first product of illegal manufacture. As the base in not soluble it is not suitable for injecting and is difficult to snort (43). Hence it is converted to its hydrochloride salt, usually by bubbling hydrogen chloride gas through an alcohol or diethyl ether solution of methamphetamine base (3, 8). This process is referred to as “salting out” and is associated (44) with the release of respirable (predominantly <1.0 μm diameter) aerosols of methamphetamine (and hydrochloric acid) that can be directly inhaled or transported throughout the premises and deposited to form methamphetamine residues on all surfaces (hard and soft). Contaminants present in these residues may be absorbed through the skin (45, 46) or ingested (from placing hands or objects in the mouth).

Waste materials: It has been estimated that for each kilogram of methamphetamine manufactured, 6-10 kilograms of waste are produced (8) that is often dumped to drains or outside, directly into the soil.

Fire and explosion: In the event of a fire or explosion, other than immediate acute hazards, contamination from precursors, intermediates, products, wastes and combustion products are more readily and rapidly spread throughout the premises and to neighbouring homes. Emergency personnel have the potential to be exposed to these contaminants if not properly protected.

2.4 Fate and Transport of Methamphetamine Indoors

The fate and transport of methamphetamine indoors has been studied more extensively than other chemical intermediates, wastes and products associated with the operation of clandestine laboratories. The behaviour of methamphetamine indoors has been determined from a number of studies (including “controlled cooks”) where levels of methamphetamine on indoor surfaces and other materials have been measured. In relation to the fate and transport of methamphetamine indoors during and after manufacture in clandestine laboratories, the available studies indicate the following:

Release and transport of methamphetamine residues: Methamphetamine is released as an aerosol during the production process and transported by air to locations distant from the site of synthesis. Hence surface residues associated with methamphetamine production are found throughout the premises not just in the room(s) used for manufacture (36, 38, 39, 47) consistent with the distribution of methamphetamine residues from smoking (48).

The initial product of methamphetamine synthesis is the free base form of the drug, which is volatile and would not be expected to persist in the environment for any significant period of time (49). The hydrochloride salt is persistent in the environment, however its stability is pH dependant (49). At a pH in excess of 4 or 5, the hydrochloride salt is more unstable and the more volatile free base is formed (49).

Activity in a residence where methamphetamine has been manufactured can result in re-suspension of respirable fractions resulting in the potential for ongoing inhalation exposures (50).

Distribution of methamphetamine residues: Methamphetamine residues on wall surfaces have been found to increase in concentration with height above the floor (51). It is not clear if the distribution of methamphetamine residues is solely due to the manufacture of the drug or if there is a contribution from the occupants who also may have smoked the drug (common in the US where the study sites are located).

Methamphetamine is absorbed into porous surfaces including concrete and paint on surfaces that include gyprock walls (plasterboard or drywall) (52, 53) and carpets (54). Elevated levels have been found in painted plasterboard surfaces (51, 55), with lower levels found in the plasterboard paper (front and back), and no detections within the gypsum itself (51).

Methamphetamine adsorbed into gyprock walls can desorb over time (depending on temperature and humidity) contributing to ongoing exposures in a home (52, 53).

Persistence: Without remediation, residues may persist for months at least, and result in exposures and contamination of clothing of all individuals who enter the premises (36, 47, 50, 53,

56). An initial study (57) on the persistence of methamphetamine residues on wall surfaces over time has indicated a reduction of approximately 50-60% after 47 days and up to 80% after 179 days (with no remediation). The persistence is expected to vary depending on a wide range of factors that include pH, temperature and humidity.

Removal and remediation: It is suggested that washing of surfaces removes a significant portion of methamphetamine surface residues, in particular dislodgeable residues which would be re-suspended with activity in the premises (55). Hence following initial cleaning of a premise the potential for fine particles of methamphetamine that can be re-suspended and inhaled is expected to be very low and not expected to be of concern. There is, however, no published data to specifically support this outcome. Work in the United States (57) and South Australia (Edwards pers. comm.) suggests that some surface contamination is easily removed, however deeper contamination in porous materials (including surfaces such as plasterboard, concrete, plywood) can be more intractable and has required repeated attempts at washing, with and without detergents and/or bleaches, before surfaces have been tested and found to be effectively remediated. Data from New Zealand (55, 58) indicates that the washing of glass windows is effective in reducing methamphetamine contamination, is partially effective for PVC, laminate or ceramic surfaces but has no significant effect on wallpapered, painted or varnished surfaces. Stronger cleaners that contain oxidisers (such as those that contain sodium hypochlorite or quaternary ammonia) have been found to be more effective in the cleaning of these surfaces (55). These cleaners have a very high pH, and given the pH-dependant stability of the more persistent methamphetamine hydrochloride salt, their effectiveness is consistent with both the cleaning process and potential conversion of the residue to the more volatile base.

The efficacy of paint encapsulation in the remediation of methamphetamine residues on plasterboard has been found to depend on the type of paint used. Encapsulation with latex paint has not been shown to effectively seal methamphetamine residues in place (51, 53, 55). Oil-based paints have been found to be more effective with the studies available indicating almost 100% still encapsulated 4 ½ months after painting (55).

Residues on porous clothing materials have been found (55) to be effectively removed with normal household washing, with a single standard wash removing more than 95% of methamphetamine contamination.

2.5 Exposure Issues Associated with Methamphetamine Laboratories

2.5.1 General

Anyone involved in the manufacture of methamphetamine, or who accesses the premises used in the manufacture of methamphetamine, has the potential to be exposed to physical hazards, precursors, intermediates (including gases), waste products and methamphetamine primarily via inhalation, dermal absorption, ingestion and accidental injection (where users are also present). In addition, one report (59) indicated that approximately 20% of laboratories discovered in homes in their study were involved in explosions as a consequence of drug activity where more severe injuries and exposures occur not only within the premises, but to neighbouring premises.

2.5.2 Drug Cooks

Limited data is available in relationship to exposures by individuals who manufacture methamphetamine within clandestine laboratories. Given these individuals are directly involved in the manufacture of the drug, exposure to physical hazards, precursor chemicals, intermediates (including gases generated) and wastes and methamphetamine during and after manufacture are expected to be significant.

Many cooks do not take basic laboratory precautions such as wearing personal protective equipment (PPE) and have limited knowledge of the consequences of mixing many of the chemicals, particularly in the presence of heat/open flames (27, 33). In addition, poor ventilation, common in illegal laboratories to avoid detection, increases the risk of exposure to high concentrations of chemicals and by-products in air as well as fires and explosions (41, 42, 60). Given the illegal nature of the manufacturing operation no specific data are available in relation to the use of PPE.

Based on a review of hospitalisation data from the United States (61), exposure issues by cooks that resulted in injuries that required hospitalisation were primarily derived from clandestine laboratories in their own residence (71%), with the remaining exposures occurring in someone else’s residence with methamphetamine, ammonia and hydrochloric acid the most commonly reported chemical exposures.

2.5.3 First-Responders and Forensic Investigators

First-responders (including police, fire fighters, ambulance officers and emergency personnel) are exposed to chemicals at a clandestine laboratory during discovery of “boxed” labs in vehicles, police raids on domestic or commercial premises or when fire fighters respond to a fire or explosion, or indirectly where these personnel treat contaminated and injured individuals within or removed from the laboratory (11, 62). Exposures by first-responders are higher during initial entry into these premises, often when the presence of the laboratory is unknown (11), compared with exposures that may occur in areas outside of, and adjacent to, the laboratory.

Acute effects have been reported in published information, primarily from the United States, by police, fire fighters and investigators at seized methamphetamine laboratories (40, 63), with a 7 to 15 fold increased risk of illness reported (64) by officers responding to a clandestine laboratory compared with those responding to premises with no clandestine laboratory. In relation to first-responders to unknown methamphetamine laboratories (with or without fire or explosion) adverse health effects and injuries have been reported (29, 65) most commonly by police officers (70%), emergency medical personnel (11%), fire-fighters (10%) and hospital personnel (9%). Chemicals exposures most commonly reported by first responders in the US are derived from inhalation, with exposure to ammonia and hydrochloric acid accounting for 54% - 58% of the injuries reported in the United States, and exposure levels to phosphine gas reported well above occupational limits (11, 42, 62). Other exposures may occur via contact with the skin and clothing of contaminated individuals removed from the methamphetamine laboratory (11, 29, 40).

The use of PPE by first-responders in the United States is poorly reported and may be as low as 15% (11, 29, 60) with only 25% of personnel decontaminating at the scene (36). PPE may be available on a planned raid of a clandestine laboratory, however the level of chemical exposure is often not known and the need for “speed and surprise” and the possibility of hostile actions and “booby-traps” (66) from occupants of the premises during the raid often limits or results in underutilisation of PPE (63). Some guidance is available (64, 67) for emergency medical personnel in relation to the identification and management of exposures in clandestine laboratories, however protocols adopted by various members of police, investigators, fire-fighters and medical staff are those specific to these organisations and jurisdictions that may or may not consider these aspects.

Once a laboratory has been seized exposures by those involved in the further investigation of the site can still occur. These investigations include the assessment phase where physical and chemical hazards are evaluated and the contents of the laboratory are determined; and the processing phase where evidence is collected and chemicals are removed (68). Entry during these phases is longer than the initial seizure phase and while PPE is commonly used during these exposures (at different levels depending on the risk) there is limited information on long term health effects associated with repeated investigations/exposures. As with first-responders there is no published data on biological monitoring that may be undertaken to evaluate exposures by long-term investigators to methamphetamine.

2.5.4 Children

In relation to children, these populations are more sensitive and considered to be at higher risk than adults who may also be present within a clandestine drug laboratory as their physiological (associated with early life developmental processes that make young children more susceptible to the adverse effects associated with exposure) and behavioural (crawling, mouthing of hands and objects, floor play activities and greater curiosity with chemicals that may be stored in accessible

areas (59)) characteristics result in a higher level of contact with contaminated surfaces (34, 69-73). Physically, children have higher metabolic and respiratory rates (69, 71) and have longer lifespans than adults over which they can develop and have to manage chronic effects of exposure (71). In children, the development of the CNS is more sensitive than adults when exposed to some chemicals, the gastrointestinal absorption differs and the development of the skeletal system results in the accumulation of some metals (34).

Children do not have the same sense of danger as adults and will not understand implications of playing with or near chemicals used in the manufacture of methamphetamine and will not be experienced with ways of escaping from emergencies such as fires and explosions (71).

Between 25% and 40% (61, 74-77) of homes seized in the United States were reported to have children present. The number of children in these premises in the United States has been observed to be increasing with the rate doubled between 1999 and 2002 (78). This may be due to the increased awareness of issues associated with exposures by children, and increased reporting of children in these premises through the introduction of Drug Endangered Children Programs in the United States. Data is limited from Australia (8, 79), in relation to the percentage of clandestine drug laboratories where children are found, or evidence that these children have been exposed to chemicals and drugs present in these homes (7).

Statements from children removed from these premises (34) that indicate that drugs were often manufactured in the kitchen, with drugs and precursors often stored in unlabelled food containers (34, 59) or in baby's cots (80), with children (particularly older children) often enlisted to assist in manufacture, and in one case a child described assisting a parent during manufacture of methamphetamine where fumes were present and only the adult was using a respirator. These types of exposure are chaotic and not controlled, and differ significantly from the type of exposure that occurs with the medical use of attention deficit hyperactive disorder (ADHD) drugs or even drug use (not smoking).

2.5.5 Neighbours

In the United States, the majority of clandestine methamphetamine laboratory incidents occurred in residential areas, with a quarter reporting injuries, or which a third are reported to be to the general (unspecified) public (81). In Australia, 71% of laboratories detected were in urban residential areas (18, 82).

Based on US data from 2000 to 2004 (83), approximately 13% of methamphetamine events (reported as emergencies) required evacuation of people from neighbouring premises (with 1 to 300 people evacuated) for a median of 3 hours. Vapours emitted from ventilation exhaust fans are at high enough concentrations to corrode metal fittings (72), and these vapours are commonly discharged from the side of premises directly into neighbouring premises. Waste chemicals

dumped in wastewater, drains, roadside waste and in public areas comprise corrosive, toxic and flammable chemicals and pose a significant hazard to the general public and the environment (62).

While information is limited in Australia in relation to exposures by neighbours, a number of more recent newspaper articles have highlighted concerns in relation to these exposures (82, 84, 85). In addition a number of clandestine laboratories have been detected on the basis of complaints from neighbours in relation to strange odours (86, 87).

No quantitative data is available in relation to the levels of contamination that may be present within neighbouring premises.

2.6 Health Effects

The available data (34, 61, 70, 73, 75, 88) is considered sufficient to support that a range of individuals, including children in clandestine drug laboratories are at high risk for injury and illness associated with immediate hazards such as fires, explosions and chemical incidents, as well as acute and chronic exposure to the range of chemicals used to manufacture the drugs as well as the drugs themselves.

2.6.1 Acute Hazards and Effects

In relation to the operation of clandestine drug laboratories, the most significant adverse effects are those derived from immediate acute hazards. These hazards include:

- The uncontrolled and unprotected storage and use of chemical precursors that are volatile, flammable or reactive. These chemicals may be explosive when mixed; and
- The release of high concentrations of toxic gases (where these depend on the method of manufacture but may include ammonia or phosphine) into a room or home where ventilation is limited and there is the potential for unprotected exposures.

Explosions and fires in clandestine drug laboratories have resulted in the death of cooks (33, 42, 60, 89, 90) and children living in the home (74); significant chemical, thermal and inhalation injuries (72, 83, 89, 91-96) that often require higher levels and longer duration of treatment when compared with other burns injuries (27, 97).

Effects consistent with those derived from the range of chemicals and drugs stored and used in the clandestine laboratory include: death; burns and irritation of skin, eyes, nose and throat; lacrimation; pulmonary oedema; coughing; chest pain; shortness of breath; nausea/vomiting; dizziness; headache; anxiety; bad taste and lethargy (5, 31, 34, 61, 71, 74, 83, 98); with exposures to high concentrations of solvents associated with liver and kidney effects (5). Accidental ingestion of methamphetamine by children has been associated with (7): agitation (most common (99)), tachycardia (second most common (99)), hypertension, hyperthermia,

rhabdomyolysis, altered mental status, roving eye movements, cortical blindness, ataxia, constant movement, seizure, flailing head, neck and extremities, hyperactivity (30), acute respiratory symptoms (100) and increased irritability/inconsolable crying (73). Children removed from homes used for the manufacture of methamphetamine often smell like cat urine as a result of the by-products of methamphetamine production (59, 75, 101, 102).

The most common acute adverse health effects reported by first responders attending methamphetamine laboratories include: chemical burns; collapse; abdominal pain; headache; respiratory irritation and effects (including breathlessness, bronchitis, cough, emphysema, pneumonia and wheezing); skin irritation; central nervous system effects and mood swings (11, 35, 65, 66, 68, 86, 102-105). A volunteer fire-fighter's lung capacity was found to decrease by 85% after attendance at an explosion at a methamphetamine laboratory (11). The available studies suggests that 93% of first-responders are likely to seek medical treatment for effects and injuries reported from methamphetamine laboratories (61). No data is available that provide results of any biological monitoring that may have been undertaken to further evaluate the potential for exposure by first-responders.

2.6.2 Chronic Effects

Chronic health effects of exposure to methamphetamine are very poorly understood (71), particularly in relation to environmental exposures to low concentrations, compared with high doses associated with drug use. However they may include: neurochemical changes in areas of the brain that are associated with learning, potentially affecting cognitive function, behaviour, motor activity and changes in avoidance responses (106); psychotic, physiological and behavioural/developmental effects that include violent behaviour, depression, irritability, hallucinations, mood swings, paranoia, mood and sleep disorders that are associated with exposure to, or use of, methamphetamine (75, 106-110); as well as effects associated with exposure to the range of chemicals present, that includes cancer and effects on respiratory, renal, hepatic, neurological, developmental and reproductive systems (5). Exposures by first-responders have resulted in chronic respiratory (including asthma and significantly decreased lung function), gastrointestinal, neurological and immune system effects (29, 63, 102, 111).

Children removed from homes where methamphetamine has been manufactured (112-116) have been reported to display a range of behavioural issues including academic difficulties (12), developmental delay (78), a higher incidence and risk of externalising (acting out) problems (112-116), aggressive behaviour (112-116), post-traumatic or dissociative symptoms (114, 115) and internalising problems (115). In addition, children in environments where methamphetamine, and other drugs or abuse, are used or manufactured can also be exposed to a wider range of other chemicals, neglect, criminal behaviour, abuse (emotional, physical and sexual) that place these

children at risk of developmental, behavioural and other mental health problems (114, 115, 117-120).

It is not clear whether early developmental/behavioural issues of methamphetamine exposure observed in children resolve over time, or lead to long-term developmental problems and a predisposition for addictive behaviours (including drug abuse) later on in life (73). Prenatal exposures (i.e. drug use) to methamphetamine have been associated with behavioural problems in children (increased emotional reactivity, anxiety/depression, externalising and attention-deficit/hyperactivity disorders) in children aged 3 and 5 years (121) suggesting the potential for long-term development effects. There are few studies available, however where follow-up data has been collected. The most extensive study involved a study on prenatally exposed children from birth to 14 years of age in Sweden (122-126). While there are limitations with the study (small size of 65 children and no control group) at 4 years of age the study suggested that the children exhibited aggressive behaviour that seemed to correlate with longer in-utero exposure periods. The study identified that parental drug and alcohol use (prenatal and while the children are growing up), along with other family factors influence children's growth and development. The study does not specifically correlate only prenatal methamphetamine exposure with long-term developmental or behavioural effects as these are confounded with a wide range of other factors associated with parental abuse of drugs and alcohol, criminality, mental health issues, poverty and family living arrangements.

A study of potential developmental effects (motor skill and cognitive function) of prenatal exposure on 166 children aged 1, 2 and 3 years (74 exposed and 92 in the control group) (127) found that at 1 year of age the methamphetamine exposed children had fine-motor skill deficits. However, these effects (as well as other cognitive functions) were not apparent at 3 years of age.

A neuroimaging study of 26 methamphetamine exposed (prenatal) and non-methamphetamine exposed children (128) suggested an abnormality in energy metabolism (increased creatine in the striatum) in the brains of children prenatally exposed to methamphetamine. These changes were not found to be associated with any increase in reported behavioural changes in the children. Further studies have identified that methamphetamine exposure during brain development affects the hippocampus (responsible for higher cognitive functions) (129) and results in cognitive impairments (130) and delayed long-lasting memory deficits (131) in adolescent mice.

2.6.3 Case Reports

Case reports relevant to children from methamphetamine laboratories where injuries or adverse effects have been reported:

- One of the earliest reports that raised the issue of hazards to children was in 1995 where three children were killed in a methamphetamine laboratory explosion (74) in the United States. The case resulted in state legislation (in California) in relation to the presence of children (under the age of 16) at methamphetamine laboratories.
- A 6-year old exposed in a methamphetamine manufacturing home was evaluated and shown to display academic difficulties and behavioural outbursts (12).
- A child with chronic asthma experienced an asthma attack in a former methamphetamine laboratory in Utah (100).
- Two case reports of children with injuries derived from ingestion of caustic agents in the home that are derived from methamphetamine production. Both children returned positive tests for both methamphetamine and amphetamine in hair (from case 1) and urine (from case 2) (98).
- A four year old was found naked, outside, playing next to waste from a methamphetamine laboratory and a dead cat. The child tested positive for methamphetamine and other illicit drugs, was infested with lice, suffered from ear infections and was developmentally delayed (78).
- Two boys received second-degree chemical burns when they fell off their bikes onto a patch of dirt in their backyard later found to contain dumped chemicals from methamphetamine production (74).
- Exposures and injuries have been reported (74) from babies crawling on carpets where chemicals used to make methamphetamine have been spilled; children using microwave ovens to reheat meals that are also used in methamphetamine production; and storages of methamphetamine and other chemicals in poorly sealed containers in food storage/preparation that are present in children's play areas.
- Case reports (61) of injuries/health effects associated with exposures to former methamphetamine laboratories and areas where waste materials were dumped include: nasal irritation (by adolescent) from waste materials dumped in a public area; skin effects by adolescent after moving into a home formerly used as a methamphetamine laboratory; persistent cough by a 4-year old after a methamphetamine laboratory was seized in the same apartment building; breathing difficulty by 1-year old child after living in a home that was a former methamphetamine laboratory; and swollen eyes in 2-year old from sleeping on carpet floor in a former methamphetamine laboratory.

2.6.4 Confounding Factors for Evaluating Chronic Effects of Exposure

Many of the published studies that relate health effects to exposures from chemicals and drugs in former clandestine drug laboratories or methamphetamine affected homes present limited information on the individuals affected, specifically details on pre-existing health.

Numerous papers (4, 30, 71, 77, 114, 116, 117, 132-136) highlight issues associated with child welfare, drug use and methamphetamine manufacturing. Children from homes where there is drug abuse and manufacturing frequently live in squalor, neglect and abuse (69, 71, 73, 135, 136) where lack of stimulation, poor nutrition, unsanitary conditions and medical problems associated pre and post-natal exposure to drugs and chemicals (12, 69). Children from homes with a history of parental drug abuse or from a home with domestic violence were 3 to 3.5 times more likely to test positive to illicit drugs in urine or hair (when analysed) (137). When evaluated, children in methamphetamine homes showed higher levels of aggression than others where it is suggested that there is the need to assess the mental health of children removed from methamphetamine homes (112, 116).

It is suggested that the combination/accumulation of multiple risk factors have a greater negative impact on psychological development (71) than the individual factors alone.

The US Drug Endangered Children program was created by the San Diego District Attorney's Office as a solution to the increasing problem of children orphaned by the arrest of their parents for methamphetamine production (74). The multi-agency program that includes procedures/protocols for the decontamination and medical assessment of children removed from these homes, and issues associated with the removal of children from these homes has been adopted in some form by a number of US states (30, 70, 75-77). Europe has established the European Network for Children Affected by Risky Environments within the Family (ENCARE), however this program focuses more on children living with parental alcohol misuse or domestic abuse. No such programs are known to be present in any Australian state.

3.0 QUANTIFICATION OF EXPOSURES

3.1 General

The most common approach adopted for the quantification of exposures by children, and others, to the presence of methamphetamine and other chemicals associated with the manufacture of methamphetamine is to measure concentrations in media relevant to exposure such as indoor air and surface residues. Chemical intakes are then estimated on the basis of the measured concentrations and parameters that estimate physiological characteristic (such as body weight), behavioural patterns (such as the time spent in contact with contaminated surfaces) and absorption. This approach is consistent with national risk assessment guidance in Australia (138) and is the approach adopted in Australia (3, 13), New Zealand (139) and many states in the United States (49, 140-151), for the derivation of assessment and remediation criteria for methamphetamine laboratories. These guidelines have been established to be protective of exposures by children, the most sensitive individuals who may be exposed to contamination. As a result, when discussing potential exposure issues, the focus relates to young children.

It is noted that the development of a remediation criteria for methamphetamine on surfaces inside a home is based on a post-remediation exposure scenario (49). This scenario assumes that some remediation of a property has occurred that removes dusts and other contaminations that could become re-suspended in the air, and that “reservoirs” of methamphetamine contamination (such as contaminated air conditioning filters and ducts and fans) are not present (49). As a result the key pathways of exposure addressed in the development of the guidelines relate to dermal contact with surfaces and objects (accounting for approximately 80% to 95% of total intake) and ingestion of contamination from mouthing hand and objects (3, 49). It is also assumed that since remediation has been undertaken, the remaining contamination degrades on indoor surfaces and depletes over time with cleaning such that exposures are considered to be sub-chronic (occurring for less than 10% of a lifetime) (152). Exposures in former drug laboratories were not considered to be chronic.

To quantify chemical intakes from exposures within a former methamphetamine laboratory requires having enough information and data to define where and how children may be exposed to these chemicals in the home data on the absorption of chemicals via the skin, data on how much surface residue sticks to the skin and other objects and can then be swallowed when placed in the mouth and, once ingested, how much is absorbed by the body. While evaluations are available that generally address key factors that influence exposures by children to environmental contaminants (153), there are a number of data gaps in this information and more specifically in the data directly relevant to exposures to methamphetamine contamination derived from former clandestine laboratories. These data gaps include (153) methods for monitoring and measuring children’s exposures and activities, collection of activity pattern data for children (relevant to all routes of

exposure), collection and use of data on environmental contaminant concentrations on all media of concern (that may need to include carpets and soft furnishings (151)), whether exposures associated with indoor air levels of methamphetamine of importance, dermal transfer coefficients and the long-term persistence of surface residues. In addition, data is lacking on the level of exposure that may occur in a former drug laboratory where no remediation has occurred.

Some of these data gaps have been addressed using assumptions or estimates in the development of Australian and International guidelines by using information obtained on the behaviour and potential for exposure to pesticides inside homes (49, 151). The relevance of these assumptions is not known, particularly where the nature and behaviour chemical contamination from the operation of a clandestine laboratory is likely to differ from known pesticide applications.

More recent studies are available in relation to better understanding and defining potential exposures from methamphetamine in indoor air, dermal exposures, dermal absorption and dermal transfer efficiencies (46, 54, 154-156) for methamphetamine. These data suggest:

- There is the potential for methamphetamine in indoor air to accumulate in skin oil, clothing, bedding, upholstery and fabric adding to potential oral intakes by young children mouthing these types of items (156). In addition there is the potential for dermal absorption of methamphetamine in indoor air be of significance (155). Indoor air pathways have not been considered in the development of existing guidelines.
- The proportion of methamphetamine that may be transferred from surfaces to skin is higher than assumed in the development of existing guidelines (46, 54, 154).

The approaches commonly used to evaluate exposure involve the characterisation of contamination in the environment where exposure may occur (i.e. measure the exposure concentration on/in different media) and/or use biological data to evaluate how much contamination has been taken into the body during exposure.

3.2 Measurement of Exposure Concentrations

No data is published or available from other sources in relation to levels of contamination within clandestine laboratories in Australia. The majority of the published data is available from the United States, specifically a number of studies conducted by the National Jewish Medical and Research Center. These studies have provided measurements of contamination levels from seized laboratories (noted to be a limited data set collected after the laboratories were seized, not operational) and from “controlled cooks”.

The controlled cooks enabled the measurement of methamphetamine in air and on a range of surfaces (hard, soft and clothes) within the cook area and in other areas of the premises away from the cook area; volatile organic compounds (VOCs) in air; acids, iodine and phosphine in air. These

studies are relevant to a range of methamphetamine cook methods and generally address three phases of operation, cooking of methamphetamine (prior to salting out phase), salting out of methamphetamine and at the completion of the cook.

A summary of the data from the available published studies is presented in **Tables 1 to 3**. These relates to the presence of methamphetamine, and some other chemicals associated with the manufacture of methamphetamine, in air and on a range of hard and soft surfaces, including clothes of people involved in the manufacture of methamphetamine (from controlled or simulated cooks where some data relate to simulated activities in the premises following a cook). It is noted that that level of contamination reported is dependent on the cook method and the volume of drugs produced. The higher concentrations have typically been reported in actual laboratories where there has been an explosion. Hence there is a wide range of levels of contamination reported from these studies.

None of the published studies provide any data on health effects experienced or biological data from any of the individuals exposed.

Assessment of aerosol sizes generated during controlled cooks (44) indicates that most of the methamphetamine aerosols present in air after a cook are respirable, with up to 90% less than 1 μm in diameter.

Table 1 Summary of Methamphetamine and other Chemicals in Indoor Air

Location/Activity	Range of Maximum Concentrations Reported in Air (µg/m^3)					References
	MA	Hydrogen Chloride	Phosphine	Ammonia	Iodine	
Data from Seized Laboratories (cook methods not specified)						
Range of different rooms from seized laboratories – after the cook	0.17 to 7.3	190 to 200	nd to 358.6	--	10 to 23	(36, 47, 51)
Suspected clandestine drug laboratories (9 locations)	0.2 to 3	--	--	--	--	(58)
Data from Controlled Cooks – Anhydrous ammonia method						
Within cook area - Cook phase - Salting out - Post cook	 10.1 to 34 127 to 680 7.6 to 79	 -- -- 895 to 1044	 -- -- --	 -- -- 90500 to 286000	 -- -- --	(38)
Away from cook area - Cook phase - Salting out - Post cook	 2.4 to 42 12 to 158 7.6	 -- -- 596	 -- -- --	 -- -- <46000 to 255000	 -- -- --	(38)
Data from Controlled Cooks - Red phosphorous and hypophosphorous methods						
Within cook area - Cook phase - Salting out - Post cook	 <0.19 680 to 5500 79 to 5500	 119 to 313 220 to 30000 75 to 14600	 -- -- nd to 18000	 -- -- --	 nd to 29 nd to 25 52 to 1600	(36, 39, 44, 47, 50)
Away from cook area - Cook phase - Salting out - Post cook	 <0.17 960 to 4000 2.6 to 4200	 30 390 to 6710 30 to 313	 -- -- --	 -- -- --	 nd to 5 -- 5 to156	(44, 47, 50)
Day following cook for no activity, medium and high activity (up to 18 hrs post cook) (1 cook) (red phosphorous method)	70 (no activity) to 210 (high activity)	nd to 67	--	--	nd to 26	(44, 50)

MA = methamphetamine
nd = not detected with a range of variable analytical limits or reporting
<0.17 = not detected above the analytical limit of reporting (LOR) which was specific or not variable for the range of data presented. The value is presented in the table as <LOR
-- = no data reported for analyte

Table 2 Summary of Amphetamine and Precursor Residue Levels on Hard Surfaces

Location/Activity	Range of Maximum Contaminant Surface Residues Reported (µg/100 cm^2)				References
	MA	AMP	EPH	PSE	
Data from Seized and Suspected Laboratories (cook methods not specified)					
Walls and surfaces that include benches, tables, floors, fans, appliances	0.1 to 6093 to 16000 after an explosion	1.2 to 34	6.6 to120	99 to 1400	(36, 47, 51, 157)
Ventilation fans	0.2 to 450	nd to1.2	nd to 6.6	0.5 to 99	(36)
Kitchen Appliances (microwaves, burners, ovens, refrigerators	nd to 16000	nd to 33	nd to 1200	nd to 51000	(36)
After 3 rounds of decontamination	0.14 to 1.05	--	--	--	(158)
Data from Controlled Cooks - Anhydrous ammonia method					
Various surfaces (3 cooks)	0.08 to 160	--	--	--	(38), (47)
Data from Controlled Cooks - Red phosphorous method					
Various surfaces (2 cooks)	6.1 to 68*	--	--	--	(44, 50)
Data from Controlled Cooks - Hypophosphorous method					
Various surfaces (painted wall, glass, mirror) up to 7 feet from cook area (2 cooks)	0.078 to 23	--	--	--	(39)
Various, including within hotel room	0.1 to 860	nd to 3.2	nd to 0.5	nd to 2.6	(36, 47)

MA = methamphetamine
AMP = amphetamine
EPH = ephedrine
PSE = pseudoephedrine
nd = not detected (variable analytical limits or reporting)
-- = no data reported for analyte
* = surface residue levels similar immediately post cook, 13 hours post cook, 16 hours post cook and 18 hours post cook

Table 3 Summary of Amphetamine and Precursor Residue Levels on Individuals, Clothes, Soft Furnishings and Toys

Location/Activity	Range of Maximum Contaminant Residues Reported (µg/sample, many as µg/100 cm^2)				References
	MA	AMP	EPH	PSE	
Data from Seized Laboratories (cook methods not specified)					
Window furnishings and sofa	0.84 to 120	nd to 1	nd	0.9 to12	(36)
Carpet	132 to 2045	--	--	--	(51)
Data from Controlled Cooks - Red phosphorous, hypophosphorous and anhydrous methods					
Personal samples from cooks (2 to 7 cooks) - Cook phase - Salting out - Post cook	 nd to 19.3 nd to 580 0.2 to 150	 -- -- --	 -- -- --	 -- -- --	(36, 38, 39, 47, 56)
Personal samples from investigators (5 cooks) - Cook phase - Salting out - Post cook	 nd to 0.14 2.54 to 580 1.1 to 150	 -- -- --	 -- -- --	 -- -- --	(56)
Personal samples – post cook (5 cooks) - police - fire fighter - juvenile - child (simulated crawling by adult)	nd to 1.6 0.46 to 56 nd to 1.18 0.2 to 29	 -- -- -- --	 -- -- -- --	 -- -- -- --	(56)
Personal wipe samples –post cook - low activity - medium activity - high activity	 0.075 to 1.7 0.32 to 56 0.59 to 44	 -- -- --	 -- -- --	 -- -- --	(44, 50)
Personal samples after decontamination (2 to 7 cooks)	0.43 to 10.2	--	--	--	(38, 39, 56)
Dog (5 cooks)	1.89	--	--	--	(56)
Baby clothes near cook (2 cooks)	6.4 to 500	--	--	--	(39)
Toys (including teddy bear)	6.4 to 1300	--	--	--	(36, 39)
Carpet	3.93 to 13	--	--	--	(36)
Carpet – vacuum samples (µg per m^2)	54 to 270	--	--	--	(44, 50)

MA = methamphetamine
AMP = amphetamine
EPH = ephedrine
PSE = pseudoephedrine
nd = not detected (variable analytical limits or reporting)
-- = no data reported for analyte

A number of limitations have been identified in relation to the available data, in particular:

- The majority of the studies conducted by the National Jewish Medical and Research Center (36, 38, 39, 47, 48, 50, 56) utilised occupational exposure based analytical methods. These methods may not be adequately sensitive for the assessment of environmental exposures by more sensitive individuals such as children.
- Few of the available studies relate to samples collected from actual seized laboratories (36, 47, 158). The majority of the data is from controlled cooks that are associated with the manufacture of small quantities of methamphetamine (noted to be approximately 3 grams (44)). There are no data that enable an assessment of the relationship of quantitative measures from the controlled cooks to those that may be derived from actual laboratories where larger quantities of methamphetamine are produced.
- There is no specific data that covers a range of housing types (including different layouts and ventilation), consideration of different actions/activities that may be undertaken by the cooks during manufacture (that may change the generation and distribution of contamination in a property), and consideration of different qualities manufactured.
- A limited number of test subjects were evaluated in relation to the measurement of residues on individuals (personal samples) conducting a range of indoor activities following the controlled cook of methamphetamine (56). This limits the overall conclusions that can be drawn on the data presented.
- No data are available in relation to the potential for systemic absorption of methamphetamine (characterised by biomonitoring data) by anyone involved in the cooking of the drugs, seizure of the laboratory and subsequent investigation of any of the premises evaluated or from exposures that may occur in the premises should no remediation occur.

Exposures in clandestine laboratories are not just limited to the manufactured drug itself. Most of the available data relates to the presence of methamphetamine in the environment, with some studies also reporting precursors and by-products that include ephedrine, pseudoephedrine, iodine, hydrogen chloride gas, ammonia gas, phosphine gas, total volatile organic compounds and amphetamine. None of the studies provide analysis of all precursors, intermediates, wastes and products of the manufacture of methamphetamine that contribute to the mix of chemicals to which anyone within the laboratory, including children may be exposed (159). Reviews of the wide range of chemicals that may be associated with the manufacture of methamphetamine (3, 160), on the basis of the nature, behaviour (including persistence) and availability of data that can be used to characterise exposure, identified a number of key chemicals that can be used as reliable indicators for the manufacture and exposure to chemicals from methamphetamine laboratories. These key chemicals include those commonly reported in the available studies.

A laboratory study (161) in relation to the recovery of pseudoephedrine and methamphetamine residues from impermeable surfaces (glass, stainless steel, adhesive vinyl laminate, stone benchtop, varnished floor wood, painted metal sheet and varnished benchtop wood) suggested that methamphetamine can be used as a surrogate to represent both methamphetamine and pseudoephedrine (where methamphetamine has been synthesised) on impermeable surfaces from clandestine drug laboratories. It is noted that data from actual seized laboratories (36) suggests this is reasonable for most surfaces with the exception of appliances within kitchens (such as microwave ovens) that are used in the manufacture of drugs where the proportion of pseudoephedrine (precursor more likely to be used in these appliances) has been found to be higher than methamphetamine. Methamphetamine could not be used as a surrogate if the laboratory were only used for the manufacture or extraction of pseudoephedrine.

Sampling and Analysis Issues

A range of analytical methods have been used in the measurement of contamination (on surfaces and in different materials) associated with clandestine laboratories (158, 161-167).

For the measurement of contamination on surfaces in premises, wipe sampling methods are commonly used. A study of the efficacy of wipe sampling methods (168) identified that it was appropriate to use either methanol or isopropanol wipes for the collection of the samples and that the presence of dust or paint on the wipe samples did not interfere with the analytical results. The recovery of methamphetamine from surfaces using wipe sampling is variable depending on the nature of the surface. Recoveries of methamphetamine residues from surfaces have been reported to be less than 100% (51, 168), with specific studies indicating variability between 15% for porous surfaces and 80% for smoother surfaces (161).

In relation to the analysis of methamphetamine, the available studies suggest the variability between laboratories ranges from 3-30% (168) to 1-50% (51).

These studies indicate that sampling and analysis methods can detect the presence methamphetamine, with the level of recovery varying between porous and smooth surfaces. In addition, some variability in the levels reported by different laboratories (between 1% and 50%) can occur. This should be considered where quantitative data from different surfaces and laboratories is compared.

3.3 Measurement of Exposure using Biological Data (Biomarkers)

3.3.1 General

Amphetamines are readily absorbed via inhalation (with between 67-79% (169) and 90% (170) absorbed into the blood stream), ingestion (with oral bioavailability noted to be in the range of 67.2% (171, 172) to 85% (173)) and dermal pathways (45). Following intake, amphetamines are rapidly distributed to the major organ systems including the brain as it readily crosses the blood-brain barrier (171). In general amphetamines are weak bases, low protein binding (174) and have a high volume of distribution which means almost all of the total amount of drug available in plasma may diffuse across cell membranes and lipid layers to tissue matrices with lower pH values than blood (175). Saliva/oral fluid, sweat and breast milk are more acidic than plasma, hence amphetamines are readily distributed to these fluids (175, 176).

Extensive reviews of the metabolism of amphetamine and methamphetamine are available in the literature (171, 177). These mechanisms do not appear to be changed by chronic exposure (178). The major pathways of methamphetamine metabolism involve (171, 177, 178):

- n-demethylation to form amphetamine, that can then be metabolised via several pathways;
- aromatic hydroxylation to form 4-hydroxymethamphetamine and then 4-hydroxyamphetamine and 4-hydrocynorephedrine; and
- β-hydroxylation to form norephedrine.

There are a number of metabolites that are produced from these mechanisms, with amphetamine and 4-hydroxymethamphetamine being the major metabolites detected in urine. In addition, amphetamine is a major drug of abuse, and it may also be present as an impurity or mixture with methamphetamine. Evaluating the presence and ratios of methamphetamine and amphetamine, both of which have relatively long elimination half-lives in the body making them detectable in various biological matrices, provides an indication of systemic absorption of methamphetamine and/or amphetamine. Following intake of pure methamphetamine, the presence of amphetamine relates to the metabolism of the primary drug and the ratio of methamphetamine to amphetamine should be greater than one (179). Hence the presence of both methamphetamine and amphetamine in biological matrices are commonly used as indicators of systemic absorption of methamphetamine.

Methamphetamine, amphetamine and their metabolites are excreted primarily in urine, with 55% to 69% excreted in the first 24-hours after exposure (171). Based on studies associated with doses typically associated with drug use, an average of 30% to 40% of a methamphetamine dose is excreted unchanged and the remainder is eliminated as metabolites (171). As amphetamines are weak basic substances renal excretion is variable and is dependent on pH. Excretion can be increased by urinary acidification, and decreased by urinary alkalinisation (171, 175).

Due to the rapid absorption and excretion of methamphetamine and metabolites the detection times for methamphetamine in most biological matrices are short. The detection times differ depending on whether exposure occurred from a single dose, repeated doses or chronic exposures. Most data is available following a single dose where the detection time is reported to range from 24-48 hours in plasma to 87 hours in urine (178). Limited data is available in relation to repeated doses of methamphetamine, however the detection time is in the range of 3 days in saliva to 8 days in urine and sweat (178, 180-182). Accumulation of amphetamines in a keratin matrix is more complex (175) but has been shown to provide a stable measure of temporal exposures with the distribution of drugs along the shaft of the hair expected to reflect historical month-by-month exposures (175).

In relation to the potential for biomarkers to be used as a reliable measure of environmental exposure to methamphetamine (and amphetamine that may be present as an impurity or as a major metabolite of methamphetamine), review of these biological matrices has considered the following factors that are considered to be important for utilising the data in a study that relates to evaluating potential environmental exposures:

1. The potential for the biomarker to be present in the matrix sampled, and be a stable measure of exposure;
2. The potential for the biomarker to report positive detections, if exposure occurred, at the point in time when samples can be collected (may be longer than a week);
3. The potential for data to be easily collected; and
4. The potential for the analysis to be able to report detections, if exposure occurred, that relate to environmental exposures from the clandestine drug laboratory.

These aspects have been considered further in relation to the use of blood and urine, saliva, sweat and hair for the potential assessment of environmental exposures. The use of these matrices for the assessment of exposure to amphetamines in the literature has primarily focused on users, with limited data available for environmental exposures. Where data is available that relates to environmental exposures much of it is presented as a positive or negative finding based on a method cut-off level typically aimed at identifying drug use, rather than a quantitative value.

3.3.2 Blood and Urine

Blood plasma is the most direct quantitative measure of the level of amphetamine and methamphetamine within the body at a point in time following exposure. The half-life of methamphetamine in plasma varies from 9.1 to 13.1 hours with a window of detection for the presence of the drug in plasma up to 24 hours (182) following exposure. In plasma, after oral administration of methamphetamine, concentrations of the metabolite amphetamine are lower than methamphetamine with the 24-hour area under the curve (AUC_{24}) for amphetamine showing a typical dose-response relationship (170, 172, 182).

As urine is the primary mechanism of elimination following exposure to amphetamines, it is most commonly used for the purpose of assessing and quantifying workplace exposures, driving relating offences and criminal cases (182-184). Analyses of urine for exposures to methamphetamine are only considered positive if the levels are above a pre-determined cut-off limit and the metabolite amphetamine is also detected. The cut-off limit is above the detection limit and allows for low levels to be present either directly or as metabolites from prescribed medicines (183, 185). Methamphetamine and amphetamine concentrations in urine are generally higher than reported in blood plasma and, while rapidly cleared from the body, can remain quantifiable for longer periods of time after multiple doses, with detections reported after 46 to 196 hours (182).

The testing for methamphetamine and amphetamine in urine is often conducted upon hospital admission to evaluate drug use. Methamphetamine cooks treated in hospital for various injuries associated with drug manufacture commonly (around 91%) test positive for amphetamines (29, 89).

One study is available where urine samples have been collected from children removed from methamphetamine laboratories (37). The children (104 children) were tested at emergency medical departments immediately after removal from the premises where 46% of the children reported positive detections (reported as detections only, no quantitative data) for methamphetamine. Of the children who tested positive, 85% were 8 years old and younger. No child tested positive more than 6.5 hours after removal from the laboratory highlighting the importance of the ability to collect urine samples within the window of detection. No information or data is available from this study on the levels of methamphetamine (and precursors) within the homes from which the children were removed.

Given the rapid clearance of methamphetamine and metabolites from the body, blood plasma or urine are not considered to be a suitable indicator of former environmental exposures, where sample collection may only be possible more than a week (and likely longer) following the cessation of exposure.

3.3.3 Saliva and Sweat

Saliva/oral fluid has been identified as an easily accessible and suitable biomonitoring method for the assessment of drugs of abuse (180). A number of studies have indicated that oral fluid methamphetamine concentrations are higher than blood plasma (170, 172, 180, 182), however there was a poor correlation between oral fluid/saliva and plasma methamphetamine concentrations reflecting high intra and inter-individual variability. While some attempts have been made to better define saliva-plasma ratios (S/P) for methamphetamine (172, 186) the measure is generally not considered to be a reliable quantitative measure of exposure, and is only considered to be a suitable matrix for screening for drug use (182).

The testing of sweat using sweat patches is a non-invasive method of biomonitoring, however only a limited number of studies are available that assist in the understanding of methamphetamine and amphetamine excretion in sweat (181, 187). Testing conducted with other drugs has identified some uncertainties associated with the method that include potential for time-dependant drug loss due to drug degradation, reabsorption to the skin, volatile losses and contamination on the skin (181, 188). In relation to methamphetamine and amphetamines, the available studies indicate that sweat testing is an effective and reliable test for detecting drug use, however significant intra and inter-individual variability indicated it should only be used as a qualitative screening test to report positive detections rather than a quantitative test (181, 187).

Given the rapid clearance of methamphetamine and metabolites from the body, and the variability issues identified in relation to the use of saliva and sweat, these media are not considered to be a reliable quantitative method for the assessment of environmental exposures.

3.3.4 Nails

Few studies are available that specifically address the use of nails as an analytical media for the detection of drugs (189). The available studies indicate that fingernail and toenail clippings have been found as reliable as hair for the detection of methamphetamine and amphetamine in users, as these drugs are well accumulated in the nail matrix, stable in the nail, retained for a long period of time, show a good correlation with hair concentrations (175, 189, 190). The mechanism of deposition at the nail matrix is complex (189, 190), hence analysis of nails are considered to be a less reliable indicator of temporal trends than hair. However analysis of nails may provide an alternate method of evaluating environmental exposures to methamphetamine.

3.3.5 Hair

General

The incorporation of drugs and metabolites into hair has been found to provide a reliable basis for evaluating historical use or exposure (191). The mechanisms by which drugs and their metabolites are incorporated into hair are complex and not fully understood (191). Conceptually it is believed that drugs and their metabolites (as well as other trace elements) are incorporated during metabolic activity and cell division associated with the anagen (i.e. formation of the hair shaft) growing phase of the hair (191). There are three recognised routes by which drugs are incorporated into the hair, as illustrated in **Figure 4**. These include incorporation of drugs from the circulatory system (192); absorption from sebum and sweat bathing the hair; and from external contamination (191).

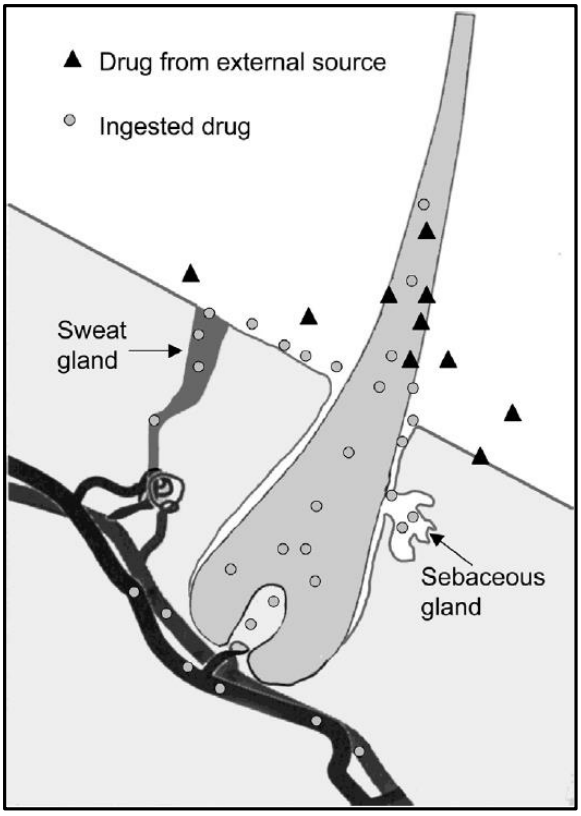


Figure 4 Routes of drug incorporation into the hair follicle (191)

Within the hair itself, the drugs and metabolites are incorporated/bound into the keratinaceous matrix of the hair shaft during protein synthesis. In the hair shaft, the materials form a stable drug bolus that remains embedded in the hair matrix. Different drugs have different affinities and binding capabilities which vary depending on drug pKa, structure, size, lipophilicity, protein binding capacity and melanin affinity (191). The lipid solubility of a drug is a critical factor for the transport of the drug from the blood stream across the cell membrane and into the growing hair (191).

In sufficiently long hair, sectional analysis can provide a timeline of drug exposure/use (192, 193). The drug is incorporated into the hair matrix as it grows with the growth rate approximately 2.8-3.2 mm per week (an average of 1 cm/month) and clearance of the drugs from the follicle cells during the 5 to 8 days after exposure (175). The testing of drugs in hair has a long window of detection and the samples can be easily collected and stored under a range of normal conditions (194).

The window of detection is limited by the length of the hair (relevant to systemic absorption where the window of detection can range from weeks to months) and, where environmental exposures are concerned, the cleanliness of the hair (deposition onto hair) (194).

Factors that can affect the stability of drugs in hair relate to the morphology and physicochemical properties of the hair as well as external factors such as exposure to sunlight and weathering, dying/bleaching/treatment of hair and curling or straightening (which damages the hair shaft) (191)

Incorporation of amphetamines in hair

Hair testing is considered to be a reliable biological and stable marker for cumulative and temporal measure of exposure to methamphetamine, with a long window of detection making it suitable for the assessment of exposure even after a long period of time has elapsed since exposure occurred.

The first study in relation to the incorporation of methamphetamines in hair was in 1954 in one guinea pig, with a large number of animal studies further conducted to evaluate the incorporation of amphetamines into the keratin matrix to investigate the pharmacokinetics (175).

Amphetamines absorbed into the keratinaceous matrix have been found to be tightly bound and are stable over long periods of time (192, 193). Amphetamines, and other contaminants that are externally deposited or not tightly bound can be removed through a series of ethanol or isopropyl alcohol washes followed by phosphate buffer washes (193). By analysing the concentrations recovered from the washes to the concentrations recovered from the hair matrix, a determination can be made that distinguishes passive or environmental exposures/ contamination from systemic absorption (192, 195). Deposition of amphetamines from air, such as from smoking or from the suspension of amphetamine residues in a home during vacuuming or from the operation of a contaminated air conditioning unit, could be a potential route of entry into hair (196).

Analysis of both methamphetamine (from systemic absorption and deposition) and amphetamine (metabolite following systemic absorption only) has been used as a quantitative method of differentiating between the types of exposure (197). From the intake of methamphetamine, the ratio of amphetamine to methamphetamine in hair is reported typically to be approximately 1:10 (175), however it is noted that this ratio has been found to increase with the duration of drug abuse (193) and presumably environmental exposures.

Melanin has been proposed as an important factor in the incorporation of amphetamines in hair (175, 198, 199). While the nature of the interaction has not been established a significant correlation has been observed in controlled human studies (200).

Dose Response

In general, hair analysis can be used to approximate dose. The mechanism of entrapment suggests that there should be a pharmacological relationship between the intake of a drug and the amount of drug or metabolite recovered from the hair (192). A positive linear relationship between dose and hair concentration has been identified for cocaine and medicinal drug use (201) with segmented analysis of hair used to evaluate changes in dose over time (202, 203). In relation to use of methamphetamine, a positive dose-response relationship has been demonstrated with rat hair (204), in drug users (205) and in a controlled study (200).

The relationship from these studies however may not be used to determine dose from the hair analysis alone as a number of researchers have reported substantial inter-individual variability in hair concentrations (192). It is suggested (192) that some of these variability issues may be due to the variety of assay protocols utilised in these studies or melanin concentrations in hair (where a significant correlation has also been observed) (200). Regardless of the variability observed it still holds that the higher the dose the higher the concentration in hair. Hence where a single competently executed assay protocol is used it has been found to provide a useful tool in rank-ordering doses (192).

Published Data on Use of Hair Analysis to Assess Environmental Exposures for Children

Hair analysis for drugs has been used in a small number of cases of suspected child abuse where proof of harm was required to be demonstrated (206).

Published reports on the use of hair analysis for evaluating environmental exposures (i.e. not drug use) to methamphetamine in children are limited (98, 194, 206-208). The available data have provided evidence of exposure by children to methamphetamine in the home as summarised below:

- In general, approximately 35% to 73% of biological samples, as urine and/or hair samples collected from children exposed to methamphetamine in the home (from drug use or manufacture), reporting positive detections results for methamphetamine, amphetamine, pseudoephedrine and/or ephedrine exposures (30, 37, 70, 71, 78, 88, 133, 208).
- More specifically, between 45% and 73% of children (with 100% from one small study of 4 children (209)) exposed to methamphetamine via drug use or manufacture tested positive for methamphetamine in hair (70, 73, 197, 208). In some cases (where data is reported) positive detections were reported in hair where no detections were reported in urine (73).
- Hair analysis of a child injured from the ingestion of caustic liquid (drain cleaner) in the US (where methamphetamine was manufactured in the home) reported detections of methamphetamine (1.7 ng/mg) and amphetamine (0.16 ng/mg) (98).
- Hair analysis data from New Zealand (208) from children removed from clandestine drug laboratories reported 73% detection of methamphetamine in hair above 0.1 ng/mg and low level detection (10%) of methamphetamine determined to be present from external contamination/deposition (i.e. in the hair wash). The levels of methamphetamine reported in children ranged from 0.1 to 131 ng/mg, with higher concentrations reported in children under 5 years of age.

The actual incidence of positive detections of methamphetamines in hair samples, however may be under reported as many jurisdictions do not conduct medical testing on children, or on all children, removed from clandestine laboratories and/or do not report these data (due to privacy issues) (78).

The level of exposure that corresponds with the detection of precursors and drugs in biological samples is not known and is generally poorly understood (4, 12, 34, 37). A study by Weisheit (27) considers that exposures to chemicals other than methamphetamine within clandestine drug laboratories is of greater concern on the basis that doses of methamphetamine expected to be absorbed by a child from contaminated surfaces is lower than doses received during drug use, and that methamphetamine is often administered to children with behavioural problems (such as ADHD). While these arguments suggest a relative understanding of potential exposures, they do not take into account the voluntary nature of drug use and monitored/controlled use of ADHD medications. Nor is the statement based on any evidence of the exposure levels that may occur within a former clandestine drug laboratory. Children exposed to methamphetamine in an operational or former clandestine laboratory have no choice (12) in relation to drug exposures and their intake and health is not monitored and managed.

Analysis Methods

In relation to the quantification of ATS (in particular methamphetamine and amphetamine) in hair samples, there are a wide range of methods (193, 194, 197, 207, 210-217) that rely on the sampling of different quantities of hair (that have the potential to affect the laboratory quantitation limit), potential inclusion of segment analysis (for evaluation of exposure over time), utilisation of different extraction methods and inclusion of methods for the evaluation of deposited and/or absorbed contamination. The washing of hair during analysis needs to be undertaken with caution as some methods have the potential to damage the hair shaft and affect the reporting of absorbed methamphetamine and amphetamine (195).

Where an analytical method is required for the quantification of methamphetamine and amphetamine (and precursors) in hair, it is important that these issues are evaluated and resolved to ensure that data is sufficiently robust.

PART B: DATA COLLECTION

4.0 AIMS

The overall aim of the project was to obtain environmental and biological data to better understand and characterise potential exposures and potential long-term health risks that may occur as a result of clandestine manufacture of methamphetamine within residential homes in Australia.

There are a range of data that could be considered for the purpose of characterising exposure and health risks, however the collection of these data needs to reflect the relevance of these data for use in Australia, being able to identify relevant candidates or premises and whether informed consent can be obtained for the collection and use of data. Different countries (such as the US and Europe) have different housing types (due to different climates and construction methods/materials), most common manufacturing methods (depending on the availability of precursors) and underlying population health. In addition, different countries manage the assessment and remediation of clandestine ATS drug laboratories within their own legal framework, which differ from that in Australia. Hence obtaining data from Australia (or New Zealand, which is similar in many of these aspects to Australia) is important for undertaking and characterising exposures and health risks in Australia.

For the purpose of characterising exposure and health risks, this study has obtained information and data from the following:

- **Interview data**: This involved the interview of individuals in Australia directly involved in the manufacture of methamphetamine who have already been convicted (where informed consent could be obtained) and Police and forensic investigators involved in the assessment of methamphetamine drug laboratories. Observations and experiences reported by these individuals in relation to the activities undertaken during manufacture of methamphetamine (that can result in contamination), exposure and health effects are relevant to this study.
- **Environmental contamination levels**: This involved the collation of environmental contamination levels in properties formerly used to manufacture methamphetamine in Australia. Environmental contamination in former methamphetamine drug laboratories are characterised as part of the assessment and remediation of these properties. Access to the data collected by remediation companies for the purpose of characterising environmental contamination for the purpose of remediation has been obtained. This provides information on the nature and extent of contamination that has been identified in a wide-range of properties.

- **Case-studies**: This involved the identification and outline of a number of opportunistic case-studies related to individuals and families unknowingly exposed to methamphetamine contamination in residential homes that have not been properly assessed and/or remediated. A number of opportunistic case studies have been included that have enabled the characterisation of exposures based on environmental contamination levels, biological data and reported health effects.

It was intended that data characterising environmental contamination and uptake by individuals as indicated by hair analysis would be collected from clandestine drug laboratories and exposed individuals just after detection and assessment by Police. This data was considered to represent the period where the highest levels of exposure may have occurred. However access to these premises was difficult to obtain as Police authorities and local Councils did not provide permission to provide notification due to legal issues. Where access was obtained, it was not possible to obtain informed consent from individuals for the collection of data. The individuals involved often included those arrested (in most cases charged but not yet convicted) or related to those arrested, and obtaining informed consent was not possible.

5.0 CHARACTERISING EXPOSURE THROUGH INTERVIEW DATA

5.1 Rationale for Interview Collection

Much of the information available in relation to the actions undertaken during cooks within clandestine drug laboratories that have the potential to affect the way in which a property is contaminated is largely anecdotal. To provide a more robust understanding of the activities and behaviours that occur during the manufacture of ATS a series of interviews have been undertaken with individuals convicted of the manufacture of ATS, i.e. the convicted cooks, as well as police and forensic investigators. The focus of the interviews undertaken was to obtain information on the type of activities involved in the manufacture of ATS that are associated with the storage and use of chemicals, generation of methamphetamine residues (and the potential for these to spread throughout a home) and the generation and disposal of waste. In addition, the presence of others in the home during the cook (in particular children) and health effects experienced by the cooks or others entering the home (during or after the cook) are of importance.

There are difficulties in obtaining specific details of activities undertaken during the manufacture of ATS as individuals involved in the conduct of the cooks are typically arrested. The process of arrest, being charged and actions through the courts mean that these individuals are reluctant to provide any detailed information that they perceive may affect their conviction. In addition, a number of individuals arrested for the manufacture of ATS are reluctant to discuss their activities due to involvement with other criminal activities or individuals (not already arrested). Once criminal proceedings have been finalised through the courts, however, a number of these issues/concerns are no longer impediments to being able to interview individuals directly involved in the manufacture of ATS. Hence this project focused on interviewing individuals in prison who have been convicted (with court proceedings completed) of the manufacture of ATS. It is expected that a large proportion of cooks that may be interviewed in prisons may not provide truthful answers to questions asked. Hence the interviews undertaken have been undertaken on the understanding that many of the individuals will not fully disclose the information requested, may embellish details or may not fully remember the details of what they were involved in during the cook (as many of the cooks are also users). Regardless of these issues the information that may be obtained from interviewing the cooks is considered to provide some insight into activities they may undertake that result in contamination, and their perception of health effects and exposure issues of concern during manufacture. This perspective is not available from any other published source.

To supplement the information obtained directly from the cooks, observational information has also been obtained from police and forensic investigators involved in the initial seizure and processing of clandestine drug laboratories. The information obtained from police and forensic investigators is

limited to observations obtained during the course of their work, however the information obtained is expected to be more truthful than obtained from the convicted cooks.

5.2 Interviews with Convicted Cooks in Prison

5.2.1 Data Collection Methods

The questionnaire developed for use in interviewing convicted cooks in prisons used a mix of direct and indirect questions, with the aim of eliciting specific “yes/no” type of answers as well as more general answers. The questionnaire (included in **Appendix A**), focused on the following areas:

A. What type of drugs were manufactured and where the manufacture took place
B. What they did with the drugs
C. Whether they were aware of the hazards involved in cooking ATS
D. What sort of modifications did they make to the home (or other premises) to cook ATS
E. Where they learned to cook ATS, where they obtained precursor chemicals, where they stored the chemicals when not being used in the cook
F. What they did with the waste
G. What, if any, protective clothing or equipment was used during the cook
H. What health effects they experienced during and after the cook
I. Who else was present when they were cooking and if any of these individuals also experienced any health effects during or after the cook
J. What motivated them to manufacture ATS, were there things that concerned them when manufacturing and what they now feel about the manufacture of ATS

All interviews with convicted cooks were undertaken as face-to-face interviews and given that it was not expected that many of the individuals interviewed would be fully open and truthful, observations were noted during the interview.

5.2.2 Selection and Access to Prisoners

Ethics approval to conduct the interviews was obtained from the Southern Adelaide Clinical Human Research Ethics Committee (Application 477.11).

Approval was obtained from the Government of South Australia, Department of Correctional Services Research Management Committee and the Government of Western Australia, Department of Corrective Services Research and Evaluation Committee (REC) to conduct interviews of convicted cooks in the prison systems in these states.

The selection of candidates was limited to those individuals incarcerated at the time where access to prison facilities was granted, and who agreed to participate (under informed consent) in the project.

South Australia:

Interviews were undertaken with prisoners in the South Australian prison system between December 2013 and February 2014.

In South Australia an initial list of potential candidates was provided by the data management team within Correctional Services. This list provided prisoner ID numbers and the name of the prison facility in which the individual was located at the time of the database search. The General Manager at each of the prison facilities where potential candidates were located were contacted directly to organise a time to visit the facility, refine the list of candidates and conduct the interviews.

Once at the facilities it became apparent that the information provided on the database was very general as it did not distinguish different types of drug crimes and hence the list included those involved in manufacture of all types of drugs and those involved in the importation/distribution of drugs. In addition, discussions with the prison officers indicated that there were some individuals in the prisons who were well known as cooks (as they liked to boast about their skills) who were incarcerated on other convictions such as parole violation or weapons convictions. These individuals were not flagged in the database search as the crime there were currently incarcerated for was not listed under a drug related crime code.

It is also noted that prisoners were moved between facilities on a regular basis for various reasons and hence a number of potential candidates were moved from facilities initially indicated within the short period of time (few months) between obtaining the initial database listing and accessing each prison facility.

To maximise the list of potential candidates for this project the approach adopted for the selection of candidates at each prison facility in South Australia was as follows:

- Obtain the database listing of potential candidates, with convictions for a general drug related crime, and check that these individuals were still located at the prison facility. Where they had moved, note down the changed location.
- Organise with prison officers to have an initial chat with each potential candidate. The initial chat was to determine if they were involved in the manufacture of ATS or if the drug conviction related to other drugs (e.g. cannabis or heroin) or the importation/distribution of drugs.
- For those involved in the manufacture of ATS further discussion occurred to provide information on the project and determine if the individual was interested in participating in the project.
- In addition to the above prison officers were asked if they knew of other individuals who were well known as cooks and had not come up on the list of potential candidates from the

database search. These individuals were also identified and discussion occurred to provide information on the project and determine if the individual was interested in participating in the project.

- Where participation was agreed, the information sheet was outlined and discussed, the information sheet was then left with the participant and informed consent obtained (refer to forms in **Appendix A**).

From this process 14 individuals agreed to participate in this project from prison facilities in South Australia.

Western Australia:

Interviews were undertaken with prisoners in the Western Australian prison system in April 2014.

In Western Australia an initial list of prison facilities (where individuals convicted of the manufacture of ATS were identified in their database) and contact details were provided. No details on individuals or convictions were provided directly. The General Manager at each of the prison facilities where potential candidates were located were contacted directly to organise a time to visit the facility and conduct the interviews. The potential candidates, where there as a specific conviction of the manufacture of ATS was listed, were identified by each individual prison and times for interviews were booked in. There was no opportunity to discuss other potential candidates who may be in the prison system on other convictions who may be well known to the prison officers as drug cooks.

As with the prisoners in South Australia, prisoners in Western Australia were moved between facilities on a regular basis and hence a number of potential candidates were moved from facilities prior to visiting the relevant facility.

The approach adopted for the selection of candidates at each prison facility in Western Australia was as follows:

- For those involved in the manufacture of methamphetamine, a meeting time was organised with the prison facility. At this meeting further discussion occurred to provide information on the project and determine if the individual was interested in participating in the project.
- Where participation was agreed, the information sheet was provided (after information on the sheet was provided) and informed consent obtained (refer to forms in **Appendix A**).

From this process 7 individuals agreed to participate in this project from prison facilities in Western Australia.

5.2.3 Responses

In total, 21 individuals involved in the manufacture of ATS agreed to participate in this project from both South Australia (14 individuals) and Western Australia (7 individuals). All participants were male aged 19 to 59, with the average age of 39. Most of the cooks interviewed were observed to look older than their age.

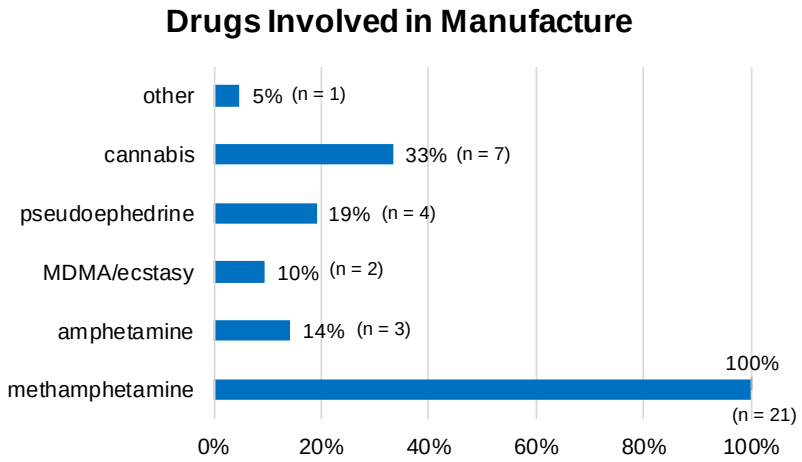
It is noted that a number of individuals (known to be involved in larger criminal organisations) refused participation in the project. In many cases they refused all discussions in relation to ATS manufacture. Some individuals refused participation as they were convinced that the information would adversely affect their prison sentence or the information would be made available to prison officers (despite assurances to the contrary).

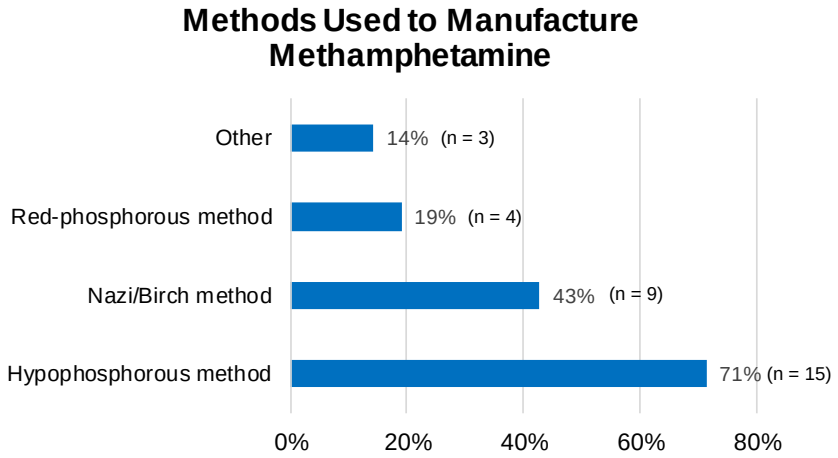
During the interviews it was apparent that the individual's current sentence or duration of time spent in prison at the time of interview did not reflect the length of time the individual had been involved in the manufacture of ATS or other drugs. Some individuals had been involved only a short period of time while others had been involved for decades.

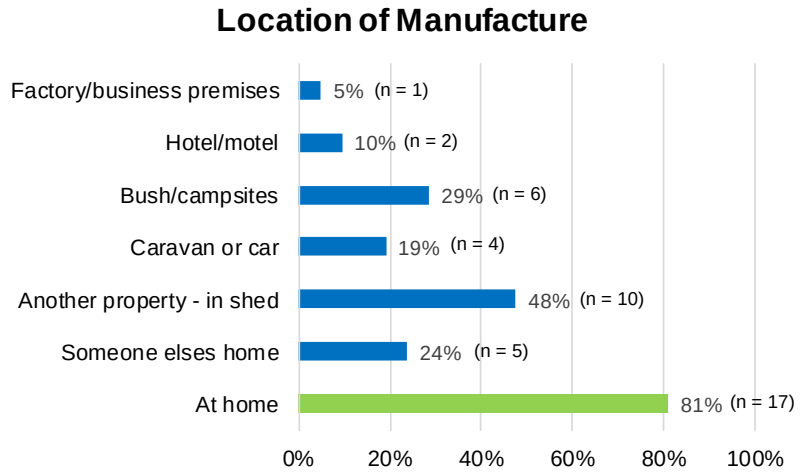
The following provides a summary of the responses obtained. Some of the responses obtained more than one positive answer and hence the percentage of responses provided (percentage of all those interviewed) will add up to more than 100%. This is because all the questions asked could have more than one response.

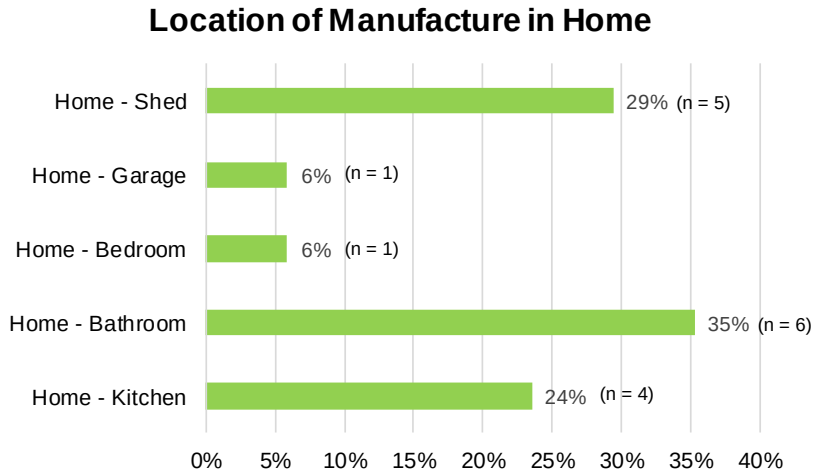
A: Type of drugs were manufactured, manufacturing methods and where the manufacture took place:

Figure 5 presents a summary of the responses provided in relation to the type of drugs manufactures, the methods used to manufacture methamphetamine, the typical location of the manufacture more generally, as well as more specifically when manufacturing within a residential home (or unit).









Note: the responses presented in green specifically relate to responses relevant to manufacture within their home

Figure 5 Responses from Cooks: Type and Location of Drug Manufacture

B: What they did with the drugs that were manufactured?

Most of the cooks interviewed manufactured methamphetamine for personal use (86% of cooks interviewed were users). Three of the 21 participants (14%) were involved solely for the purpose of manufacturing large quantities for sale and were not users.

Of the cooks who manufactured for personal use, they indicated that they also did the following with the drugs they manufactured:

- 39% sold the drugs for money to help cover the cost of their next cook
- 6% used the drugs to barter for precursors to use in their next cook
- 6% gave some of the drugs to others to help them out

C: Awareness of the hazards involved in cooking ATS

All the individuals interviewed were aware of the following hazards associated with the manufacture of methamphetamine:

- Fire and explosion
- Toxic fumes
- Acids and alkalis
- Solvents and other chemicals

Most (67%) of those interviewed were aware of the risks of being found out and the consequences of being found out.

While being aware of the hazards many provide a range of responses, that illustrate their general perception of these hazards and risks that included the following:

- Minimal risk of fire/explosion and not concerned about toxic fumes – the chemicals used are common household chemicals
- Low level of risk as they "*knew how to handle chemicals*" or they were "*always careful*"
- Aware the risk of fire and explosion was high so was always aware of surroundings and ensured the cook was in shed away from others, and always kept gas away from the cook
- Low risk from fumes as "*insects in shed were all OK – so it can't be that bad*"
- Was involved in explosion in someone else's house. Cannot afford to pay for the repairs ($26,000 approximately) and wants to serve more prison time rather than pay for the damages

D: Types of modifications did they make to the home (or other premises) to cook ATS

Figure 6 presents a summary of the responses provided in relation to the types of modifications that were made to premises for the purpose of manufacturing ATSs.

Where a cook occurred inside a structure most of the cooks used some form of fan to vent gases and fumes. Most of the cooks that were undertaken inside homes involved shutting up the home so they would not be noticed.

A number used inventive techniques to keep the fumes out of the area where they were doing the cook. These included:

- Using a rubber balloon to collect fumes from the condenser, then releasing the fumes outside
- Cooking in the bush in a tent and putting the top of the condenser out a hole in the roof of the tent and sealing around the hole
- Using damp towels to absorb odours during the cook and washing the towels after the cook. There was no elaboration on the placement of the towels during the cook

One of the cooks noted that they could observe methamphetamine residues on the walls after the cook. They would then wash down the wall with bleach at times to clean up the walls.

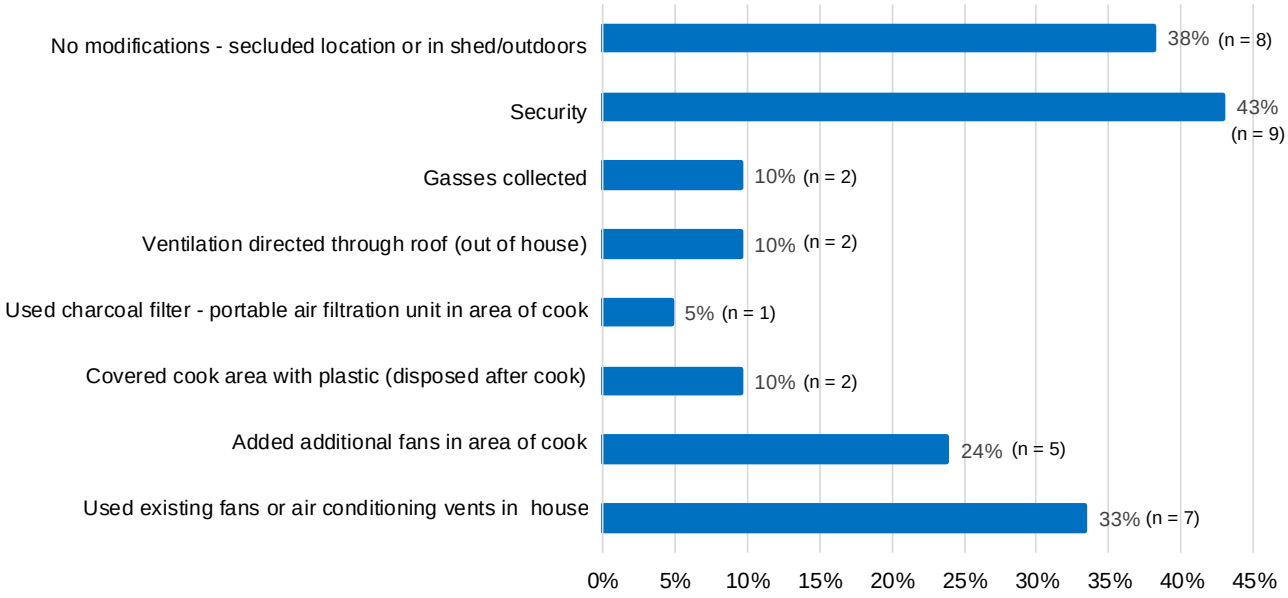


Figure 6 **Responses from Cooks: Home Modifications**

E: Where they learned to cook ATS, where they obtained precursor chemicals, where they stored the chemicals when not being used in the cook

Figure 7 presents a summary of the responses provided in relation to where the cooks learned to manufacture and where they obtained precursor chemicals.

Not all of the responses provided in relation to this question during the interviews were considered to be truthful.

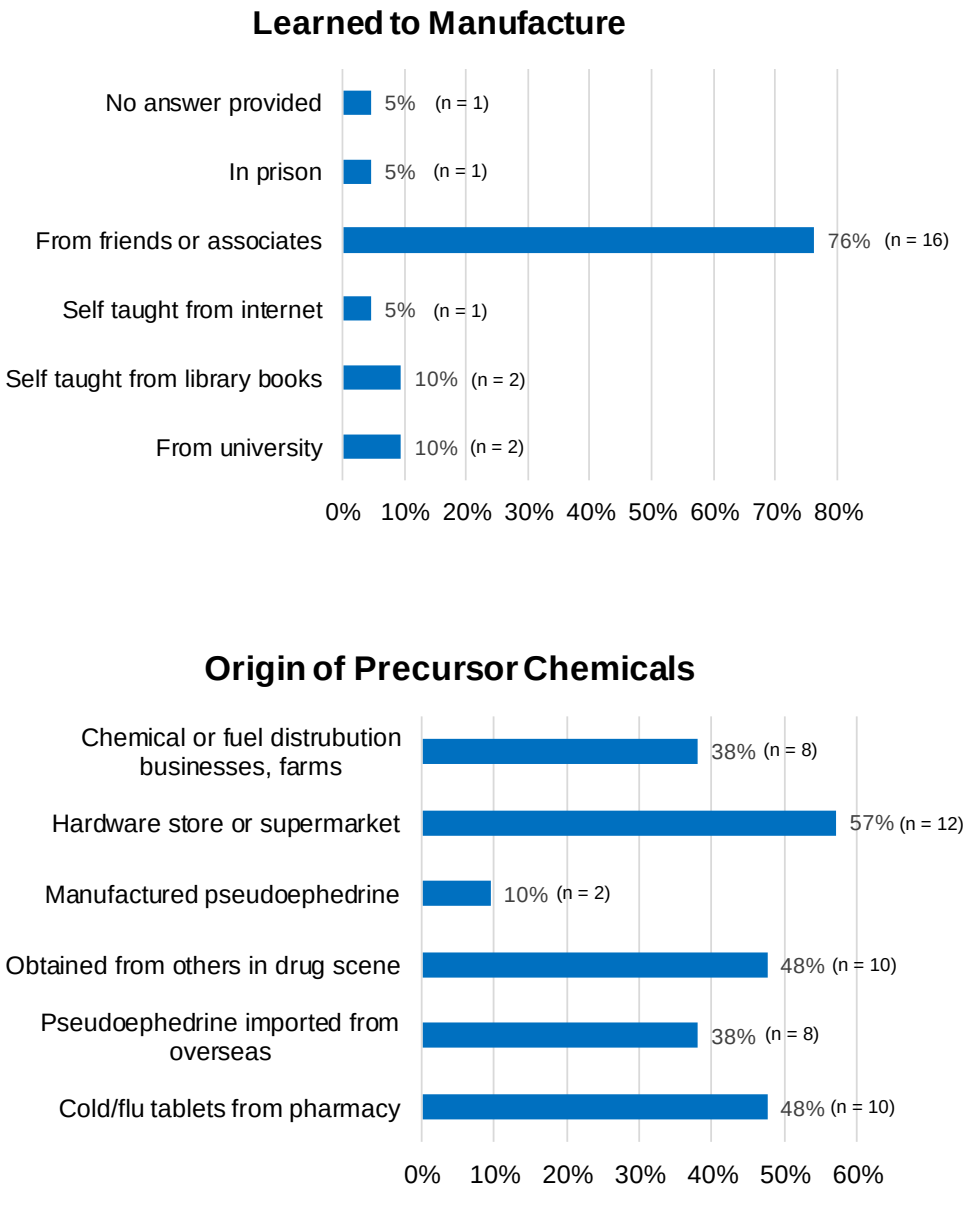


Figure 7 **Responses from Cooks: Source of Precursors and Where They Learned to Manufacture ATS**

It is noted that from the interviews the restriction on purchasing cold and flu tablets containing pseudoephedrine from pharmacies in Australia was not seen as an impediment to the manufacture of methamphetamine. The individuals interviewed indicated that while it has made things a bit harder they always seem to be able to obtain pseudoephedrine from “mates”.

In relation to where the cooks stored chemicals before, during or after manufacture **Figure 8** provides a summary of the responses provided.

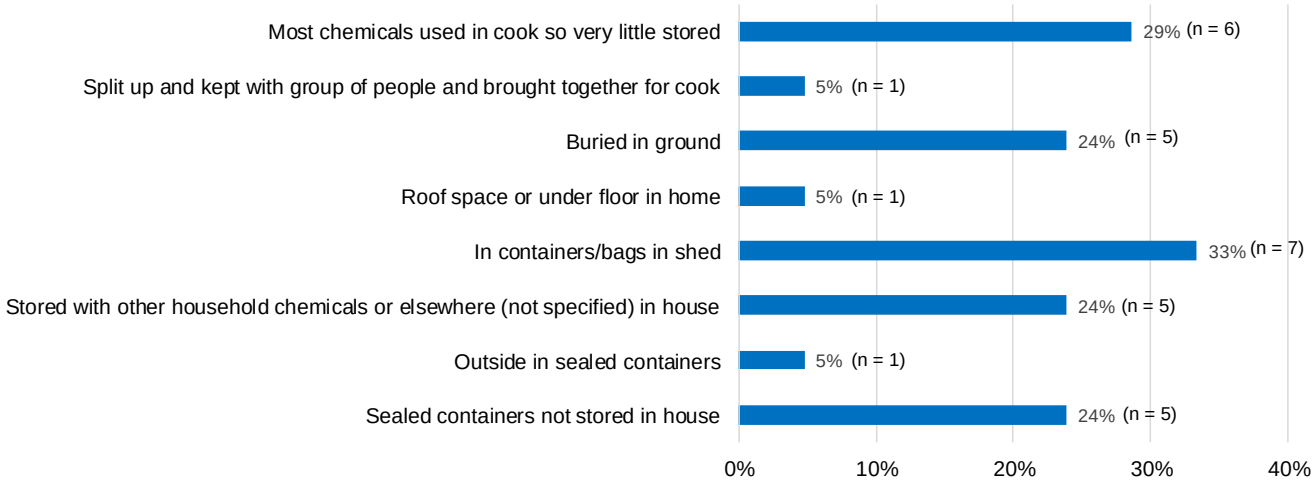


Figure 8 Responses from Cooks: Where they Stored Chemicals used in Manufacture

A number of the individuals interviewed were keen to state that they kept chemicals away from the home and away from children. This response was not perceived to be truthful during the interviews. Rather it was perceived as a comment/statement they thought they should make, potentially to avoid further prosecution or investigation.

F: Where waste was disposed

Figure 9 presents a summary of the responses provided in relation to where waste generated during the cook was disposed/dumped. Most tipped the waste down the drain or toilet, however a significant number admitted to dumping the waste into the environment or putting back into drums for dumping at any other location they could find (rural area or dumpsters) that would conceal what they were doing.

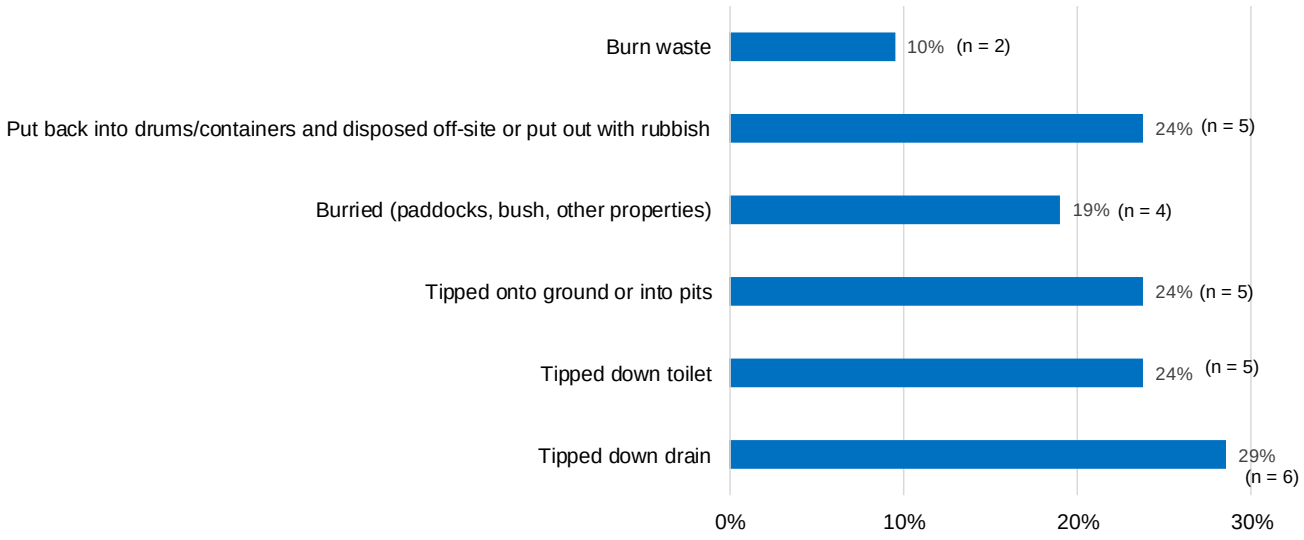


Figure 9 Responses from Cooks: Location of Waste Disposal

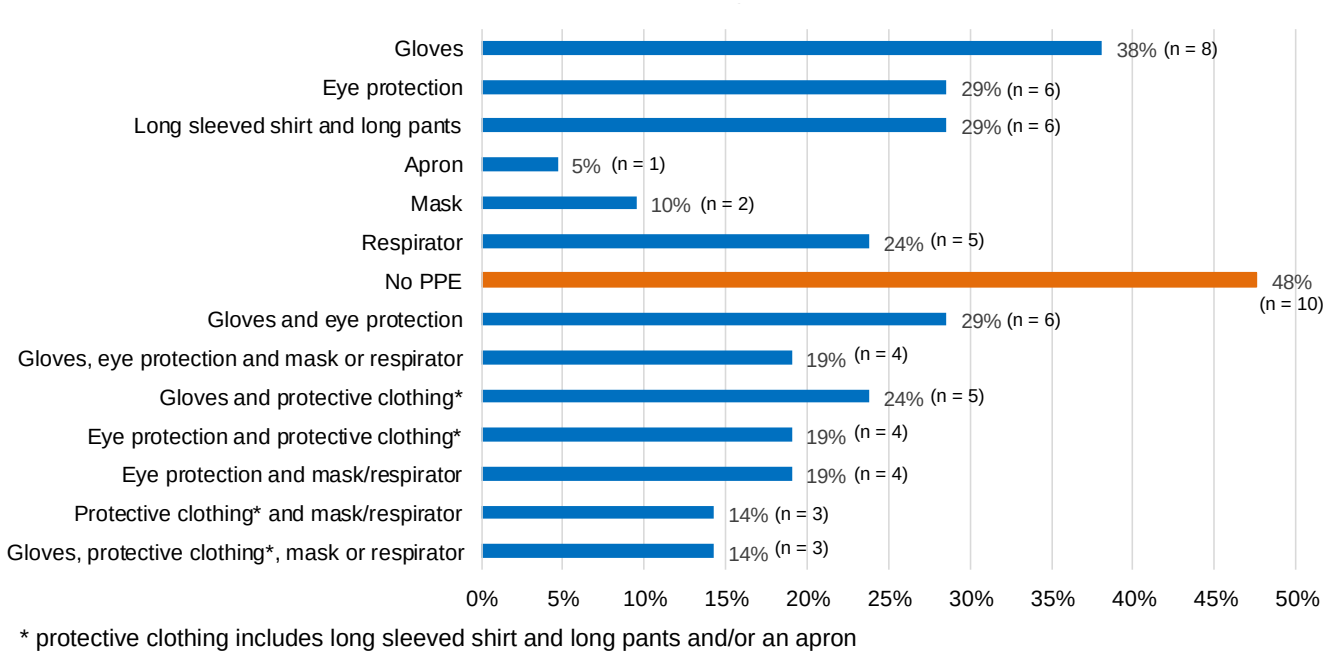
G: Protective clothing or equipment was used during the cook

Few of the cooks regularly used any protective clothing or other equipment such as respirators or eye protection. The reason given for the limited use of protective clothing and equipment was most commonly provided as they “knew what they were doing” and “took care”.

A number indicated that they tried gloves but they got in the way of the cook or would just get holes in them from solvents and acids/alkalis so stopped wearing them. In addition, a number indicated that they tried using a respirator (typically one purchased from a hardware store for spray painting) but it was too uncomfortable to use so they stopped using it. One of the cooks indicated that he wore very little to cook, essentially shorts only (no shirt or shoes).

One cook indicated that they used a full chemical resistant suit with respirator where the filters were changed for each cook.

Figure 10 provides a summary of the response provided in relation to their own use of PPE during the cook.



* protective clothing includes long sleeved shirt and long pants and/or an apron

Figure 10 Responses from Cooks: PPE used during Cook

H: Health effects reported to have been experienced during and after the cook

Most of the cooks interviewed (86%) were also users of ATS and it was considered unlikely that these individuals would have noticed or remembered any significant health effects they may have experienced during or after the cook. This correlates with the low number of common health effects associated with the manufacture of ATS reported by the cooks. It is noted that many of the cooks reported that they would get a “high” from the cook itself and for the users this was part of the benefit/attraction of doing the cook themselves. If they used methamphetamine after the cook they would get a “double high”.

A number of the cooks interviewed indicated that in relation to the fumes and odours, this was something they got used to over time and hence they did not consider the irritation (particularly respiratory effects) associated with the fumes was an adverse effect of the cook. Where the cook reported a cough they indicated that it would only last a short time (not persistent).

Figure 11 provides a summary of the responses provided in relation to the health effects the cooks experienced during and after a cook.

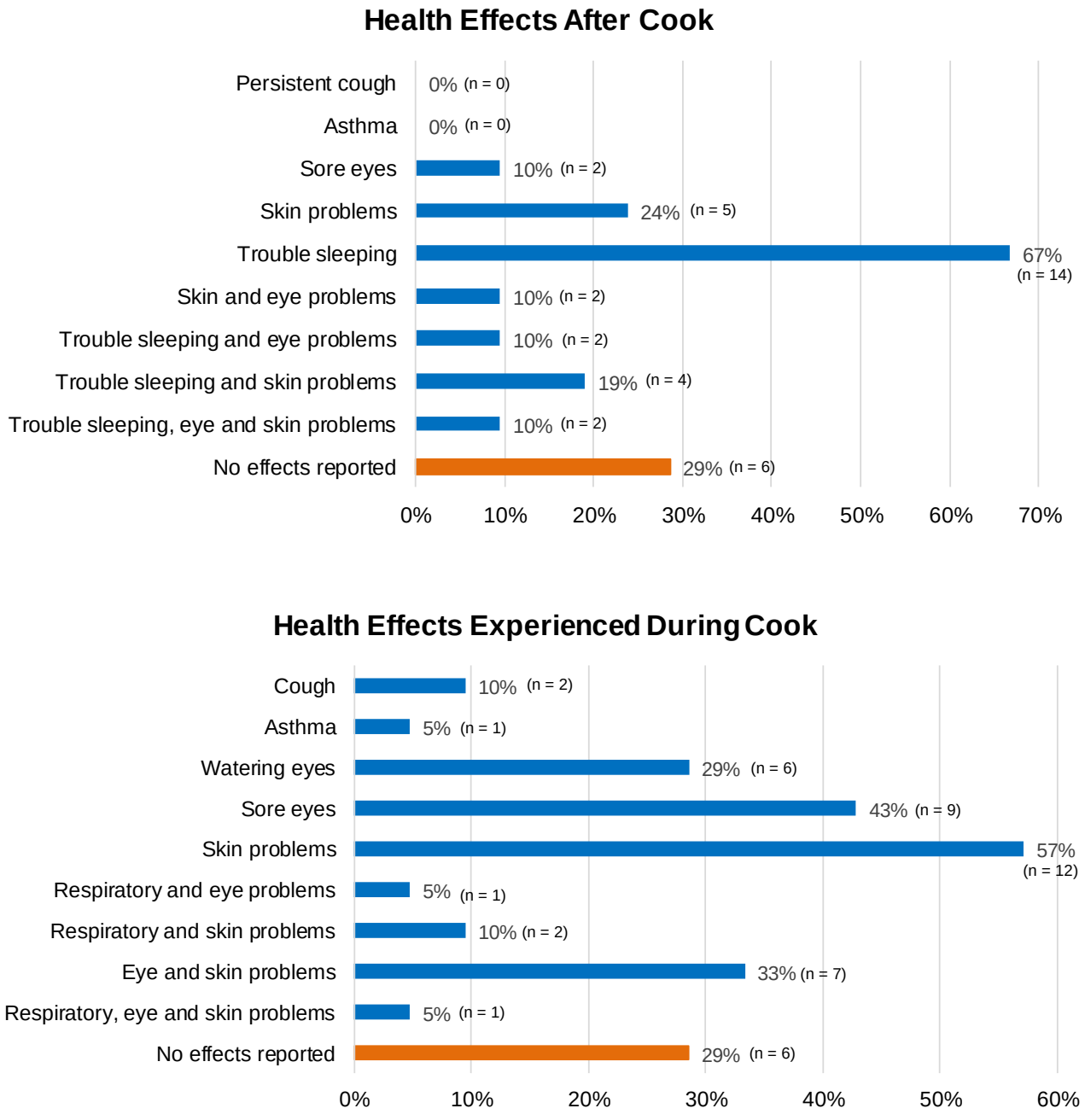


Figure 11 Responses from Cooks: Health Effects Reported During and After Manufacture

Most of the participants indicated that after the cook they had trouble sleeping, but that may have been due to the fact that they were users and this was a normal issue for them.

Other health effects reported during the cook included:

- Chest pains during one of the cooks – went to hospital but was released the following day
- Feeling anxious or depressed
- Feeling run-down and tired
- Would break out in pimples if they did the cook without a shirt, or would aggravate pre-existing psoriasis
- Observed that others involved in the cook who did not wear protective clothing and equipment went bald

Very few health effects were reported to persist after they had stopped cooking. The effects that were reported to persist included the following:

- Ongoing issues with pre-existing psoriasis – not knowing what was from cooking methamphetamine and what would have occurred anyway
- Ongoing tiredness with one cook reported to have slept for 2 weeks straight when incarcerated, and he remains “tired and dopey”
- Some burns lasted for 2-3 weeks
- One cook noted that he had permanently lost his fingerprints due to the burns on his hands

All the cooks interviewed considered themselves to be in good health at the time of the interview. However many did indicate that now that they are clean they are concerned about their long-term health from both using and cooking. A few identified health complaints that they considered to be from other factors, which included diabetes (which was believed to have affected the vision in his right eye), glandular fever and chronic fatigue (not considered to be properly treated in prison).

I: Who else was present when they were cooking and if any of these individuals also experienced any health effects during or after the cook

Answers to these questions were most notably observed to be evasive and very few individuals interviewed wanted to spend much time discussing these questions any further. It was perceived that many of the answers were deliberately deceptive. **Figure 12** presents a summary of the responses provided in relation to who was present when the participants were conducting a cook.

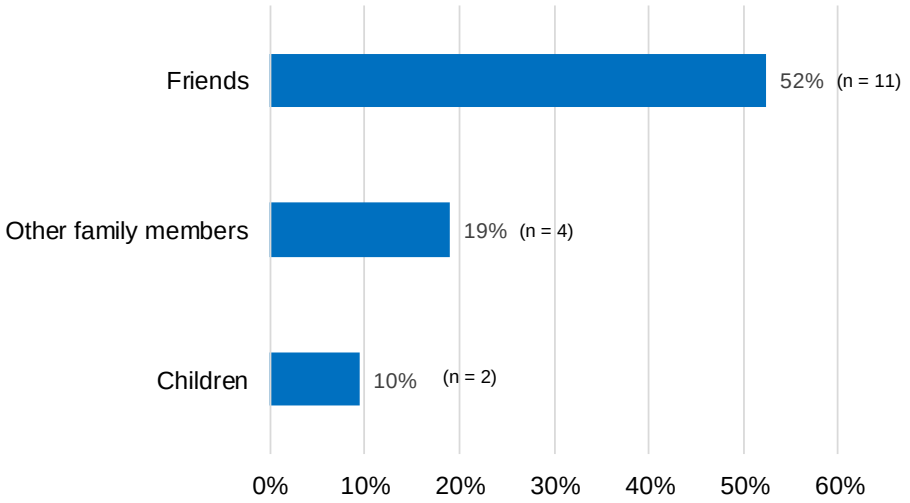


Figure 12 Responses from Cooks: Others Present during Manufacture

Where other people were present at the time of the cook, few of the cooks indicated any of these individuals experienced health effects. The health effects noted were:

- Eye irritation, so they would not “hang around” for long
- Cough and irritation, so they could not be in the room with the cook due to trouble breathing
- Would dislike the smell and would not stay in room where cook occurred
- Had some burns on hands

One of the cooks indicated that he observed other cooks that showed signs of psychosis from drug use, but not himself.

J: What was the motivation to manufacture ATS, were there things that concerned them when manufacturing and what they now feel about the manufacture of ATS

For the cooks interviewed the key motivations reported for manufacturing methamphetamine was:

- Feed their habit
- Monetary - to save money as it was cheaper to make than buy off the street, to avoid having to steal to fund drug habit, to make money (mainly in relation to those who cooked to sell not use)
- Control - to have control over the product they used. Many believed that the quality of drugs bought off the street was poor, variable, and unknown and potentially dangerous
- Wanted to stay away from other criminals in the drug scene

When cooking methamphetamine the main thing that the cooks were worried about was getting caught. Other things they worried about were:

- No being able to get the precursors
- Everything
- Health effects particularly in relation to future health (worried cooking may cause cancer)

Most stated they were not worried about fires/explosions or other hazards as they "*knew what I was doing*" and made sure they were "*smart about what I did*".

When interviewed in prison all the cooks (who had been users) were off drugs. Most of the cooks indicated that they were "*done with drugs*" and did not what to come back to prison. They had seen things they had missed out on including kids birthdays' indicated that drugs had damaged relationships, ruined business and jobs. One indicated that the costs of drugs was too high as he had lost his younger brother and sister (murdered) to violence from the drug scene. A few indicated that they worry about what will happen when they get out of prison as cooking methamphetamine is what they know how to do, as they don't have any other skills, and it is an easy way to make money. They worry that they will get "sucked" back into cooking again.

A number of the cooks interviewed could not understand the concern about contamination from cooking. They cannot understand how buildings get contaminated as "*meth disintegrates in the air*" and see all the testing and clean-up as "*over the top*".

5.3 Interviews with Police and Forensic Investigators

5.3.1 Data Collection Methods

To obtain a different perspective on aspects of a clandestine drug laboratory that relate to characterising exposure and health effects, police and forensic investigators involved in identifying, seizing and processing clandestine drug laboratories were interviewed.

The questionnaire developed for use with police and forensic investigators used a mix of direct and indirect questions. Some of the questions also asked for a ranking, for example from most common to least common, as some of the officers interviewed had a depth of experience that covered a significant number of laboratories. The questionnaire (included in **Appendix B**), focused on the following areas:

A. The type of drug manufacturing, methods and manufacture locations they have observed during their job
B. Observations on the behaviour and health of the drug cook
C. Who else they observed to be at the premises
D. If children were present, what observations do they have in relation to their health
E. Whether they had been at an ATS laboratories where there were fire/exposures, toxic fume or strong odours
F. What were their observations on the storage of chemicals and precursors used in the manufacture of ATS, and the disposal of waste
G. What sort of modifications to the home/premises have been observed
H. What protective clothing or equipment is typically used when entering a drug laboratory, and if they have been exposed to chemicals associated with the manufacture of ATS without PPE
I. What health effects they may have experienced from duties involving ATS drug laboratories
J. Attitudes to clandestine drug manufacture

The questionnaire was directly completed by participating police and forensic investigators as well as used by the researcher in face-to-face interviews.

5.3.2 Selection and Access to Police and Forensic Investigators

Ethics approval to conduct the interviews was obtained from the Southern Adelaide Clinical Human Research Ethics Committee (Application 477.11).

Approval was obtained from Western Australia Police for their officers to participate in the project. In addition forensic investigators from ChemCentre in Western Australia who work with the Western Australia Police consented to participate in the project.

Approval was sought from NSW and Victoria Police for the participation of their officers in the project, which was declined. However 2 retired forensic investigators who previously worked with NSW Police and Victoria Police agreed to participate in in the project.

Discussions with both Western Australia Police and South Australia Police indicated that officers within the drug squad (who dealt with clandestine laboratories) were rotated out of the squads each 2 years (to minimise corruption). Hence many of the officers who agreed to participate from Western Australia had limited experience.

Police standards for the use of PPE at clandestine drug labs is strict. Discussions with South Australia Police indicated that it would be difficult to find any officers who had any experience with health effects or comments on PPE as they were all required to follow their guidelines (which would prevent exposure and health effects) and no one would admit to not following the guidelines. It was perceived that obtaining open observations on exposures and health effects from officers in South Australia would be challenging and further efforts to obtain formal approval were not sought.

The selection of candidates was limited to police and forensic investigators from Western Australia and retired investigators in other states who agreed to participate (under informed consent) in the project.

5.3.3 Responses

In total, 15 police officers or forensic investigators who have been involved with ATS drug laboratories agreed to participate in this project between April and November 2014. This included all police officers on-duty, no including those on leave, in the Western Australia Police drug squad.

The participants comprised 13 males and 2 females, aged 25 to 69 years, with an average age of 39 years. The length of experience in dealing with ATS drug laboratories range from < 6 months to 9 years for the currently active police officers and forensic scientists. The retired forensic investigators had more experience, with 16 and 39 years working with ATS laboratories. For the police officers involved in the study the average length of experience was 1.6 years, reflecting current policing policies where officers spend limited time in the drug squad. Forensic investigators are not subject to the same policies, with the length of experience is higher, averaging 6 years for active investigators. **Figure 13** presents a summary of the number of drug lab/seizures the participants have been involved in during their duties:

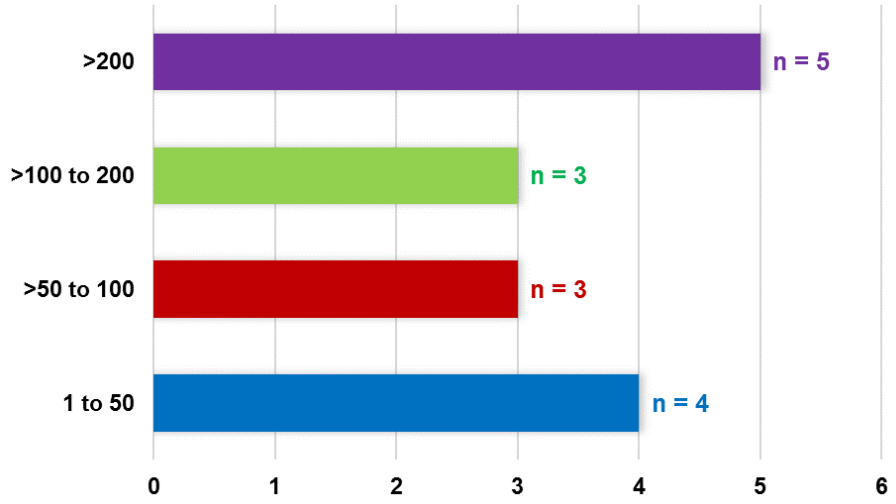


Figure 13 **Police and Forensic Investigators: Drug Laboratory Experience of Participants (number of laboratories attended)**

The following provides a summary of the responses obtained. Some of the responses obtained more than one positive answer and hence the percentage of responses provided (percentage of all those interviewed) will add up to more than 100%. This is because all the questions asked could have more than one response.

A: The type of drug manufacturing, methods and manufacture locations they have observed during their job

Figure 14 shows the type of drug manufacturing that participants in the project have experienced during the conduct of their duties. For these participants, methamphetamine drug laboratories are the most prevalent with these making up 80% to 100% of the drug laboratories they have been involved with. The other drug manufacturing listed below are experienced infrequently.

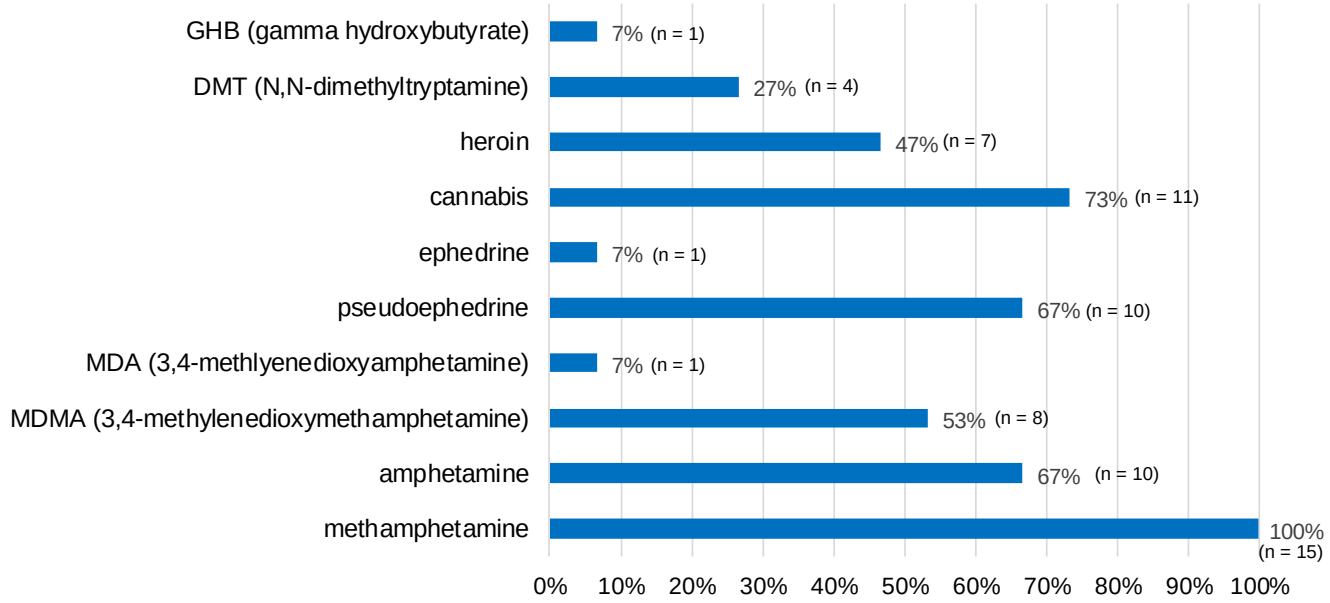


Figure 14 **Responses from Police and Forensic Investigators: Types of Drug Manufacturing Encountered**

The participants in the project have observed all the common types of methods for the manufacture of methamphetamine. As the majority of the participants are from Western Australia the most common method of manufacture encountered was the Nazi/Birch reduction. Investigators from the eastern states of Australia noted the more common methods of manufacture encountered were the hypophosphorous method and Red P method. This is consistent with statistics collected by the Australian Crime Commission in relation to methods commonly used in Western Australia and in the eastern states of Australia (2). Other methods noted by the participants include the Leuckart method (present in the 1980's and early 1990's) and manufacture from benzaldehyde.

In relation to the location of manufacture the investigators have observed manufacturing in a wide range of locations. **Figure 15** summarises the manufacturing locations observed by the investigators and the ranking of these locations into the broad groups of most common, less common and infrequently encountered locations.

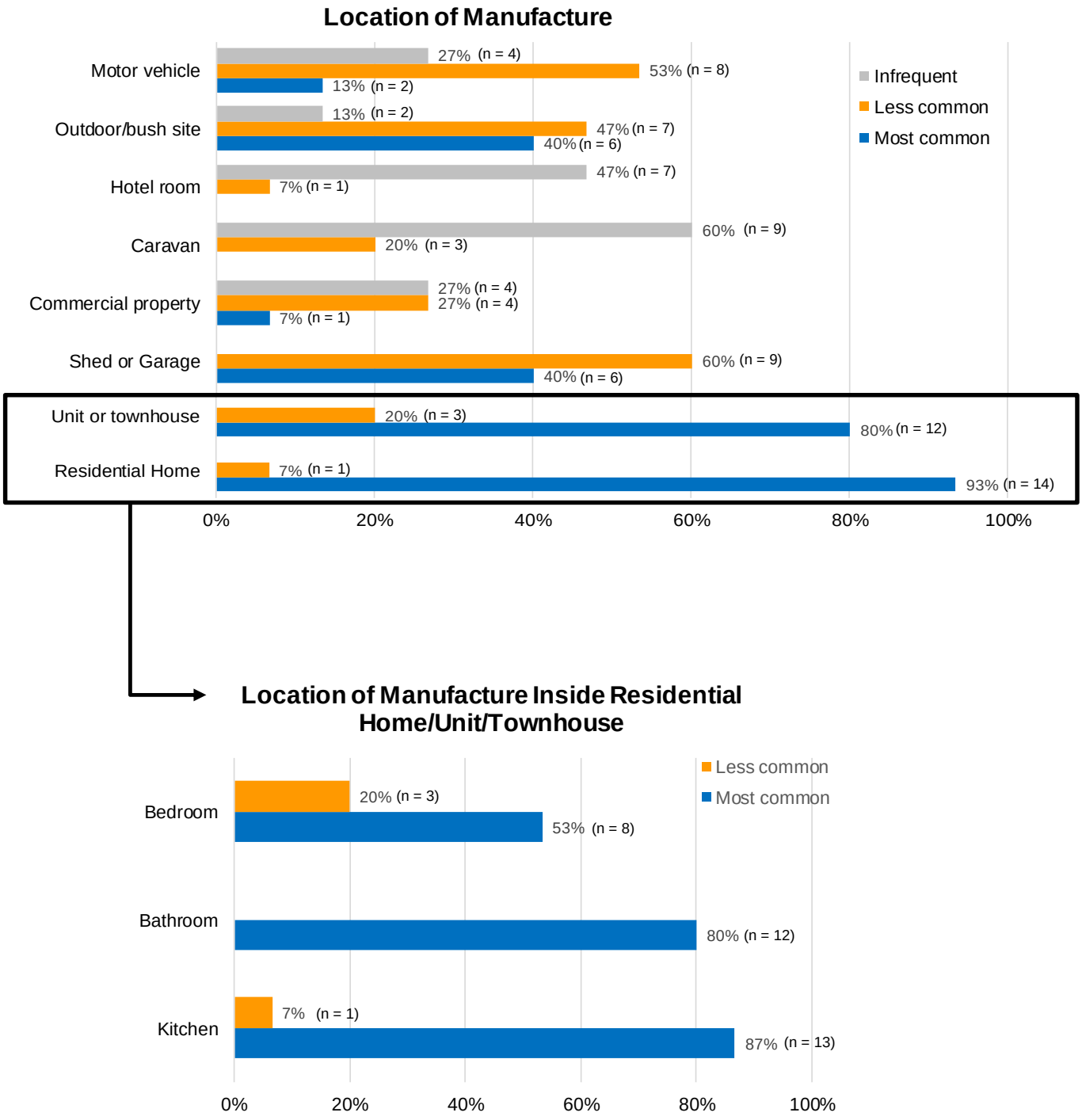


Figure 15 **Responses from Police and Forensic Investigators: Location of Manufacturing**

B: Observations on the behaviour and health of the drug cook

Participants who were forensic investigators typically did not observe the drug cook or others found inside the premises as their work was conducted after police had removed the offender and all others from the premises. Hence observations of the behaviour and health of the cook are primarily derived from police officers participating in the project. **Figure 16** presents a summary of the observations provided from the participants who were in a position to be able to observe the cooks.

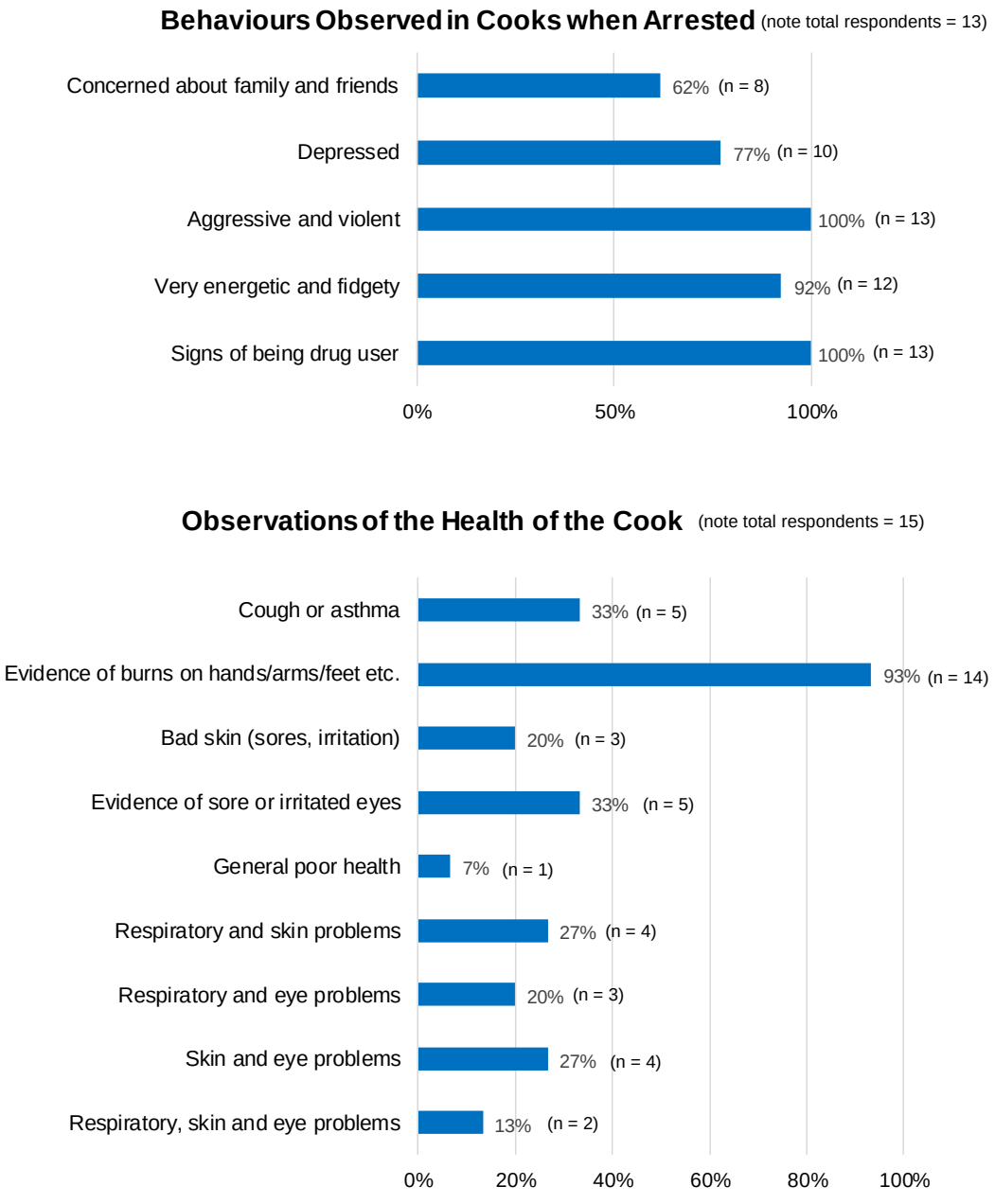


Figure 16 **Responses from Police and Forensic Investigators: Observed Behaviours and Health Issues with Drug Cooks**

C: Who else they observed to be at the premises

Observations of others present at premises were based on direct observations of other individuals by police officers as well as observations of possessions/property that remained in the premises when other forensic work was being undertaken. The questionnaire asked for an estimate of the likely percentage of properties where different groups of people may have been present. **Figure 17** presents a summary of the range of percentages reported in this study, with the minimum, maximum and average shown. Where children were observed to be present, the participants indicated that these individuals were present at 10% to 50% of the properties attended, with an average of 25%. For other family members the range of observations were limited to range between 20% and 40% of the premises attended. A wider range of observations were reported for partners, friends and other drug criminals.

It is noted that during the completion of the questionnaire some participants were notably more observant and descriptive than others. In particular it was observed that female participants provided more detailed responses than male participants. Hence it is likely that the observations provided in relation to who may have also lived at the property (based on possessions that may have been left in the property) are likely to have been under-reported by some of the participants.

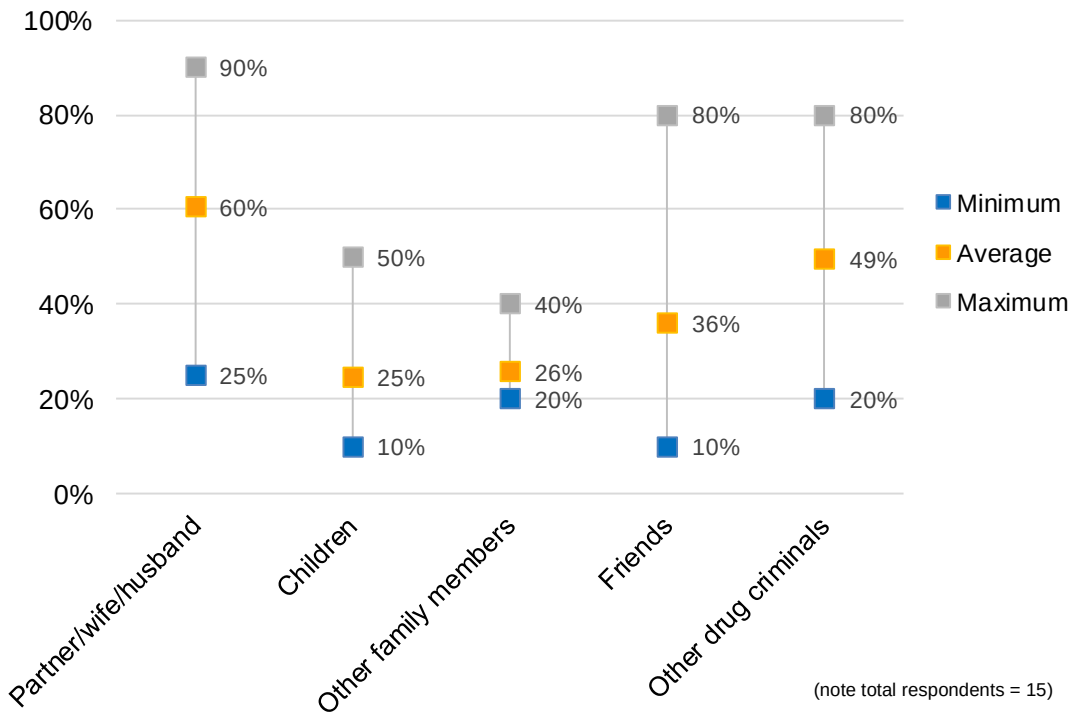


Figure 17 **Responses from Police and Forensic Investigators: Observations of the Presence of Others at the Drug Laboratory**

D: If children were present, what observations do they have in relation to their health

Participants who were forensic investigators typically did not observe children found inside the premises as their work was conducted after police had removed the offender and all others from the premises. Hence observations of the health of children are primarily derived from police officers participating in the project. **Figure 18** presents a summary of the observations provided in relation to the health of children present at drug laboratories. The most significant observation related to poor hygiene.

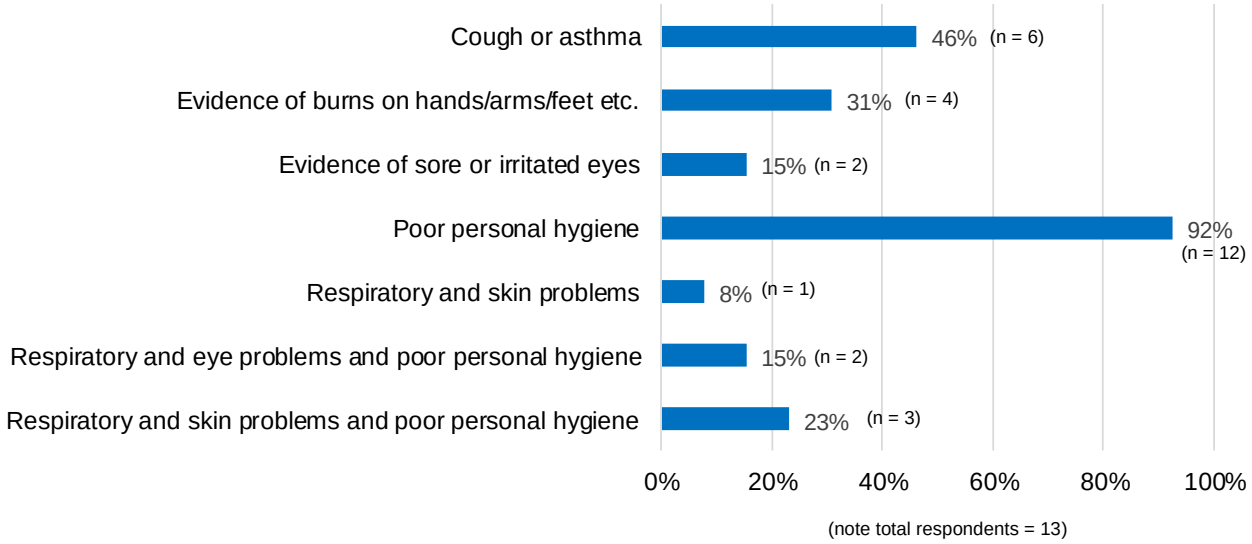


Figure 18 **Responses from Police and Forensic Investigators: Observations of the Health of Children at Drug Laboratories**

E: What were their observations on the storage of chemicals and precursors used in the manufacture of ATS, and the disposal of waste

Participants in this study reported a wider range of observations in relation to the storage of chemicals and precursors. Most (93% to 100%) reported observing chemicals stored on benches (with and without lids) or on shelves in garages/sheds. There were less observations of storages in the refrigerator (60%). Other observations noted include the following:

- Stored in numerous locations, highly variable depending on the criminals involved
- Concealed in vehicles, hidden within compartments
- Chemicals not stored correctly in 99% of the laboratories
- Often used improvised containers not intended for chemical storages e.g. glass/plastic bottles, dishes, jars, jerry cans etc.
- Seen chemicals stored everywhere in a house, in every room (including the pantry), sometimes hidden and sometimes not

- Most chemicals can be passed off as common household chemicals so they see a lot stored together in garages and sheds
- No care taken with the storage of acids and alkalis. These are often placed in other unmarked containers, stored together
- Some cooks would store chemicals in unmarked containers that were colour coded so only the cook knew what chemicals were in each container

In relation to the disposal of waste **Figure 19** presents a summary of the observations reported. It is noted that the participants indicated that it was often difficult to determine if waste had been disposed of down drains inside or outside unless there was specific evidence at the drains (such as staining, powder residues or damage to the drain). Hence the observations provided relate to aspects of waste disposal that are more readily visible after disposal.

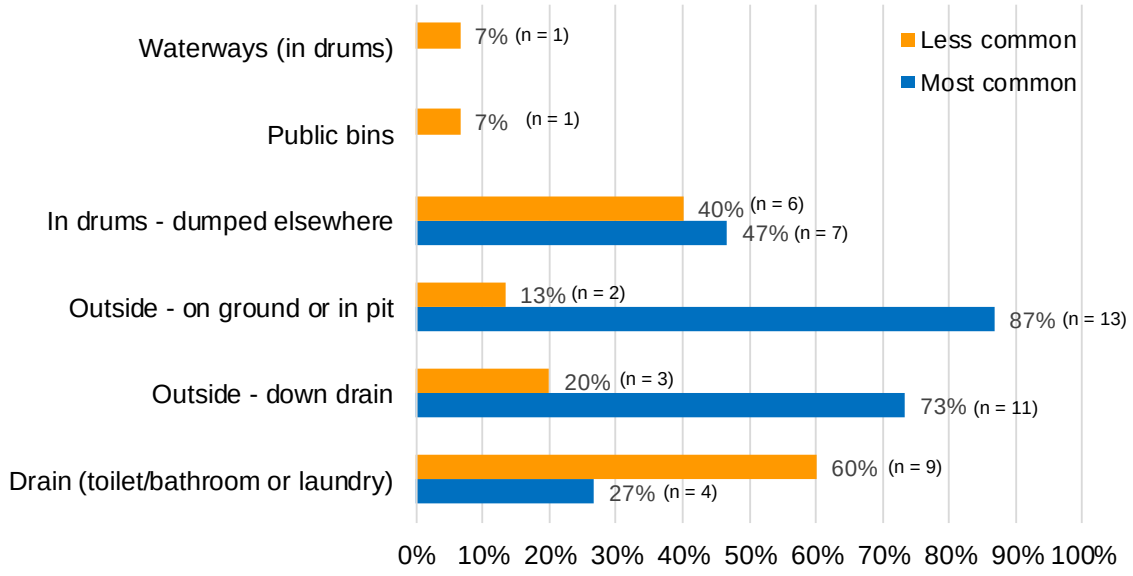


Figure 19 **Responses from Police and Forensic Investigators: Observed Locations of Waste Disposal**

F: What sort of modifications to the home/premises have been observed

Observations of modifications to premises used for manufacturing ATSs, presented in **Figure 20,** were based on direct observations within the premises where the participants were working. It is noted that during the completion of the questionnaire some participants were notably more observant and descriptive than others, potentially due to the nature of their involvement at the property (where those involved in arrests and handling initial evidence may not have time to make observations about all aspects of the property). Some participants stated that they did not notice any modifications. Hence it is likely that observations of modifications within the property are likely to have been under-reported by some of the participants.

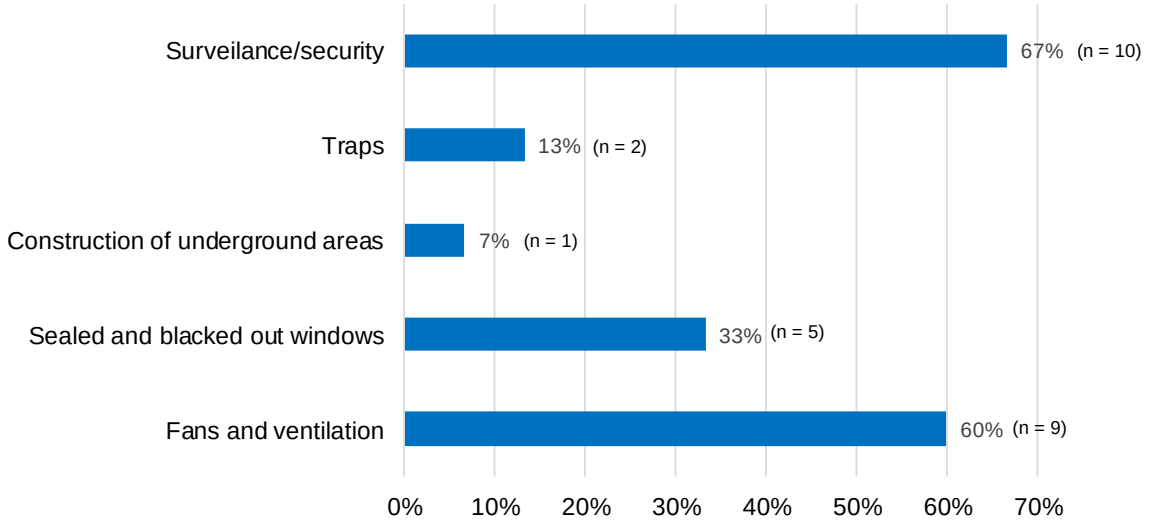


Figure 20 **Responses from Police and Forensic Investigators: Observed Modifications to Home for Drug Manufacture**

Some participants made the statement that many of the cooks used what was within the home itself with no specific/additional modifications and the home looked just like any normal home from the outside.

The data obtained indicated that the most common modifications related to surveillance/security and the use of additional fans and ventilation.

G: Whether they had been at an ATS laboratories where there were fire/exposures, toxic fume or strong odours

All the participants had attended at least one drug laboratory where there were strong chemical or other unusual odours. Most of the participants (73%) considered that they had attended a premises where toxic fumes were present. The most recognisable gas/fumes reported by participants was ammonia, with some reporting solvent odours. Investigators experienced over a long period of time also report a distinctive and highly persistent odour associated with the use of phenylacetic acid (in earlier drug laboratories).

Most (93%) of the participants had attended at least one drug laboratory where a fire or explosion had occurred. One had attended a situation where the drug cook deliberately set fire to and blew up the drug laboratory as police were seizing the premises. In addition the investigator attended an active laboratory where there was significant off-gasing observed. Even when ventilated off-gasing from clothing and furnishings meant it was odorous for a long time.

H: What protective clothing or equipment is typically used when entering a drug laboratory, and if they have been exposed to chemicals associated with the manufacture of ATS without PPE

All active police and forensic investigators have worn a range of PPE, with the level of PPE worn on an as needs basis (varies for each situation). This includes full self-contained breathing apparatus, chemical and/or fire resistant overalls and boots. The minimum level of PPE worn typically includes undergarments, overalls, boots, gloves, safety glasses and respirator.

For investigators involved in work that spanned a significant period of time they noted the following:

- In the 1980's and in some cases the early 1990's the level of protection was minimal, typically involving only a lab coat or overalls
- More specific requirements for PPE came into force in 1989 to 1993 when awareness of PPE for police and forensic investigators was raised based on information and experience from the United States
- As time progressed from there the requirements for PPE have become more refined and strict

As most of the participants in the project are active police officers and forensic investigators where they work under strict protocols for the use of PPE, only a few have reported situations where they have been in a drug laboratory where they were not wearing PPE. Where they have been exposed the key issue identified was the presence of ammonia gas.

Investigators involved in drug laboratories for a longer period of time, that covered periods of time where there were less strict PPE requirements, identified situations where they and others were present in drug laboratories without the appropriate PPE.

I: What health effects they may have experienced from duties involving ATS drug laboratories

As most of the participants in the project are active police officers and forensic investigators where they work under strict protocols for the use of PPE, only a few have reported situations where they have experienced any health effects. The health effects reported by these participants (i.e. active investigators) are summarised in **Figure 21**.

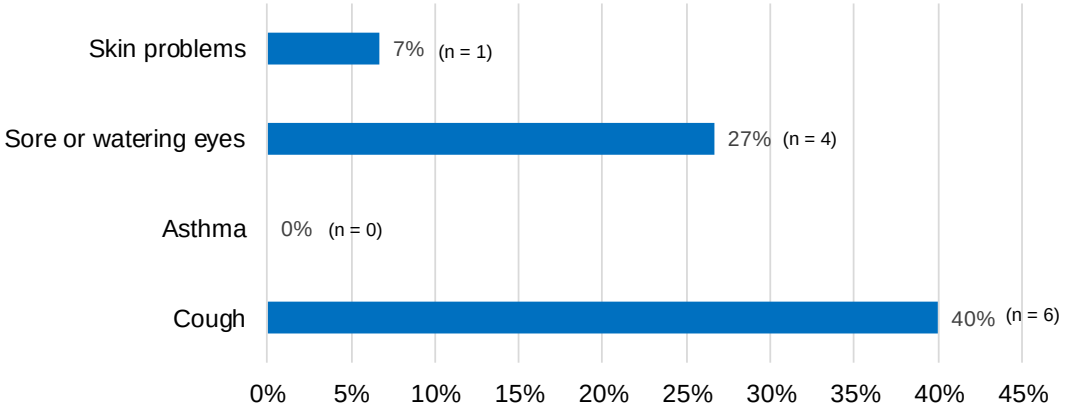


Figure 21 Responses from Police and Forensic Investigators: Health Effects Reported

In relation to investigators involved in drug laboratories for a longer period of time, that covered periods of time where there were less strict PPE requirements, the following health effects/issues have been reported:

- In the earlier days of investigating clandestine drug laboratories there was no monitoring of health. When health monitoring came in, there were no problems found with the lung function test (despite being previously exposed to fumes/odours in drug laboratories without appropriate PPE)
- Exposure to amphetamine in an active lab occurred without appropriate PPE. Testing of urine the following day reported positive detections for amphetamine
- Police photographer sustained permanent eye damage from caustic powder that got caught in the wind as it picked up power from a surface and blew it into the eyes

None of the participants reported any long term health effects that may be associated with their duties in investigating drug laboratories.

J: Attitudes to clandestine drug manufacture

The following presents a summary of the attitudes of the police and forensic investigators involved in this study to the manufacture of drugs:

- Dangerous
- Dirty process undertaken mainly by low level dealers and users
- Ongoing problem in regional and industrial areas to avoid detection
- Put the safety of themselves and others at risk, significant risk
- Endangers lives and property
- Major community issue (affecting all aspects of society) that needs to be addressed
- Believes a lot more children and other people being harmed than we know about. We only know where a drug laboratory is detected. Need better monitoring in hospitals to see if children are presenting with injuries or illnesses that may be related to drug laboratories
- Problem is more widespread than it appears as the police do not detect the labs
- Have little sympathy for the cooks, but do feel for others caught up in it
- Most of the homes are also squalid

5.4 Outcomes from Interview Data

The interview data obtained in this study involved a relatively small number of individuals (21 convicted cooks and 15 Police and forensic investigators), however the information obtained provides qualitative data/evidence on the attitudes and behaviours of those involved in the manufacture of methamphetamine, potential and perceived health effects of these activities by those involved in manufacture as well as those involved in Police investigations.

In relation to characterising exposure the activities undertaken by individuals involved in the manufacture the interview data collected is important as it has provided insight into where and how chemicals are used, stored and disposed, the most common locations for manufacture, what happens to gases emitted during the manufacture and how this may result in the contamination of a property. The reporting and perception of health effects by convicted cooks was found to be limited in this study as the majority of those interviewed were also users. In addition it is noted that some information provided by the cooks was perceived to be deceptive or inaccurate, particularly in relation to the presence of, and health effects experienced by others, particularly children. Regardless of these limitations the data provides insights from the cooks' perspective, not available from other sources.

Information from Police and forensic investigators provides contrasting attitudes to the hazards present in a clandestine drug laboratory and the level of risk this may pose to their (and others) health. The observations provided by Police and forensic investigators provide an insight into

chemical use, storage and disposal, the presence of children, the behaviour of those involved in manufacturing and health effects of those inside the premises as well as their own experiences with exposures and health effects. While the information obtained from these individuals was perceived to be more honest and open, it was noted that a number of individuals were not very observant or descriptive in responding to the questions.

In the absence of being able to obtain informed consent from cooks (and other individuals) directly involved in the manufacture of ATS, at the time when they are exposed or immediately after exposure, the data obtained from interviews provides qualitative data that can be considered in this study (refer to **Section 9** for further discussion of these data). As noted above there are some limitations to the interview data obtained, and these limitations need to be considered in any application of the data.

6.0 INFORMATION AND DATA FROM REMEDIATION OF FORMER CLANDESTINE DRUG LABORATORIES

6.1 Purpose

Since the release of the Australian Guidelines on the Remediation of Clandestine Drug Laboratories in 2011 (13), the remediation of former drug laboratories has required some level of assessment to determine if a premises is contaminated and in some cases, at what level the contamination is present. As a result a number of companies involved in the assessment and remediation of clandestine drug laboratories have been undertaking contamination assessments within premises that have been reported by Police to local Councils as being a former ATS drug laboratory.

Companies involved in the assessment and remediation of clandestine drug laboratories have been approached and permission obtained from a number of these companies to obtain and collate data collected for the purpose of characterising contamination within former drug laboratories. The aim of collating this information is to obtain an understanding of the range of concentrations of methamphetamine residues present within premises that were formerly used for the manufacture of methamphetamine in Australia. In addition information was obtained to further assist in understanding the nature and spread of contamination in these premises.

Some data is available from laboratories in the US, however no data is published on the levels of contamination found in premises in Australia.

6.2 Data Collection Methods

Ethics approval to collect and collate environmental data was obtained from the Southern Adelaide Clinical Human Research Ethics Committee (Application 477.11).

Permission was not obtained from police or Council authorities to enable identification and notification of former clandestine drug laboratories for detailed testing of contamination levels due to issues in complying with privacy laws. Hence the data obtained in relation to the level and spread of contamination has largely relied on sampling undertaken by others.

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

- Data collected by companies involved in the assessment (and sometimes remediation) and validation of former clandestine drug laboratories. This data (anonymised) was obtained from a range of companies and as a result included a range of different assessment techniques and sampling approaches. In addition the data collected reflected both

quantitative and semi-quantitative methods. Quantitative methods involved laboratory analysis to provide precises levels of methamphetamine residues on the surface. All quantitative results were obtained from commercial laboratories using gas chromatography-mass spectrometry (GC-MS) methods.

- Data collected by the researcher using semi-quantitative methods from a limited number of former clandestine drug laboratories identified in SA Housing properties. Flinders University has an established Memorandum of Understanding (MoU) in relation to the testing of former clandestine drug laboratories in SA Housing premises. Where former clandestine drug laboratories were identified during the research period these premises were sampled using a semi-quantitative method (as outlined below) by the researcher. In addition information about the property was also collected during the site work.
- WA Health Database: the Western Australian Department of Health currently maintains a database of information provided by WA Police in relation to the nature and type of clandestine drug laboratory identified at a premises. In addition the police report provides a preliminary assessment or ranking of the level of risk posed at the property (Level 1 or Level 2). WA Health provided access to this database for the purpose of this research.

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.

In obtaining information of the level of methamphetamine contamination in premises, where available additional information available about the premises and specific observations within the premises 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

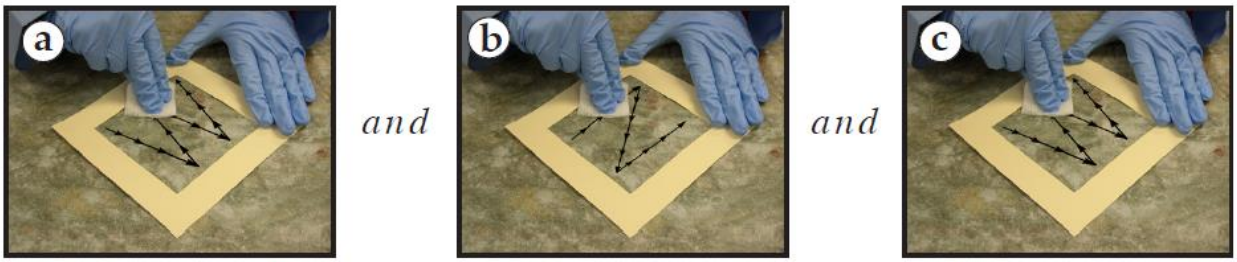
addition not all investigators report details about the property (with none of the reports providing details on whether the property is open-plan or has isolated rooms) or other observations that may be relevant to this study. The information provided was not consistent between the different companies 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 (13). Hence the information and data considered in this study is limited by the methods adopted and the information provided by each company for each individual property.

Semi-Quantitative Sampling Method

A semi-quantitative immunoassay sampling method 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 µg/100 cm^2. The accuracy of the MethChek tests was reported to be ≥ 97% within ± 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 are reported (218).

For the sampling undertaken by the researcher test kits that provided a 0.05 µg/100 cm^2 lower cut-off or reporting limit were used. Data collected by others, and presented in this study, utilised kits with a range of different cut-off

The sampling involves moistening a clean cotton gauze or cotton bud with a wetting agent (99% distilled water) and wiping a defined 10cm x 10cm square area (or equivalent area if a square area is not available). The wipe sampling technique employed is illustrated below (219):

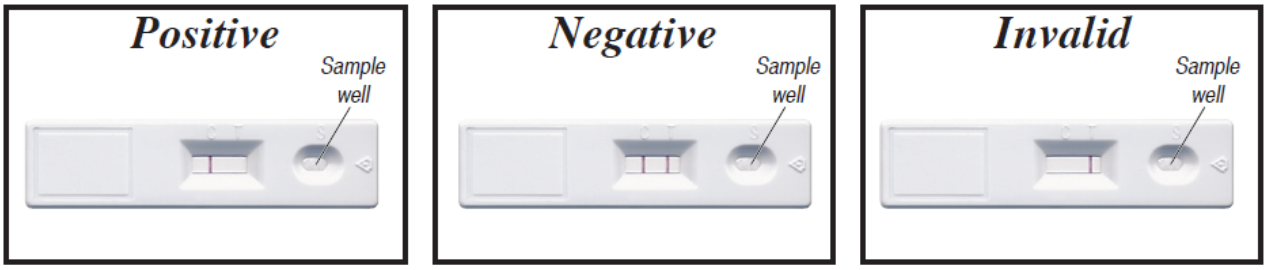


a. *Left to right in a "W" pattern*

b. *Left to right in a "Z" pattern*

c. *Repeat left to right in a "W" pattern*

The gauze/cotton bud is then placed into a glass vial with 1 mL of isopropanol extract, the lid put on the vial and shaken to ensure the isopropanol extract is in full contact with the gauze/cotton bud. The vial is then opened and three drops (removed with a dropper) of the solution is then placed into the sample well of the immunoassay cartridge. The results of the test take approximately 5 minutes to develop. The following illustrates how the immunoassay tests are read (219):



Positive
Meth residue detected above kit lower limit of identification

Negative
*Meth residue **not** detected at kit lower limit of identification*

Invalid test
Perform new test

The samples collected are given a unique identifier, with the location of the sample (and the sample ID) marked up on a sampling plan of the premises. The results of the testing are reported.

For some properties where the MethChek test was positive, a dilution was performed, such that the sample solution of 1 mL was diluted in 1 mL or 10mL of extract and the immunoassay test repeated. This provided an increased limit of identification from 0.05 µg/100 cm^2 to 0.1 µg/100 cm^2 or 0.5 µg/100 cm^2. This enabled a range of concentrations to be determined for the sample. The method does not provide a fully quantified result.

6.3 Results

6.3.1 Properties included in Study

Assessment information has been obtained from 100 individual premises in Australia. The data obtained is 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).

One property from South Australia was excluded from this review as the tenant of the property (who had been arrested for manufacture of methamphetamine but was released on bail) had attempted to clean the premises prior to sampling. Preliminary tests at the property indicated most areas had been cleaned with residual contamination remaining on uncleaned surfaces only (e.g. window behind fly-screen). This premises was excluded from the detailed review as data from the premises was not representative of contamination that may be present following manufacture, prior to cleaning and remediation.

For premises included in this study the data is distributed as indicated in **Figure 22**.

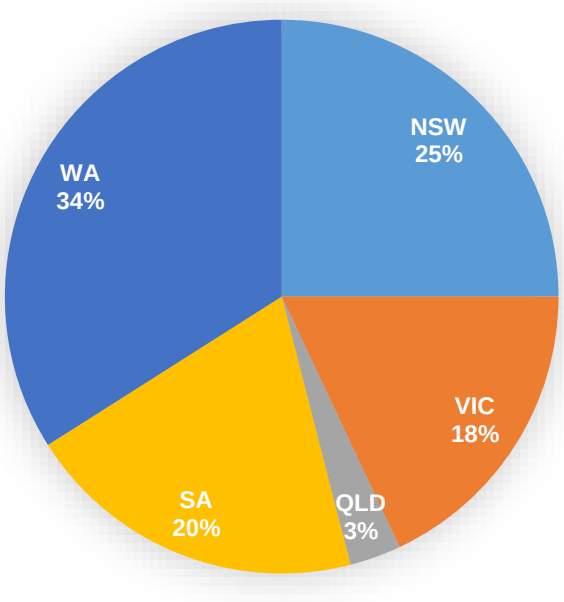


Figure 22 Contamination Data - Location of ATS Laboratories

Types of Properties:

Figure 23 presents a summary of the types of properties included in the study. The majority (88%) of the properties were located in urban areas, with these equally split between privately owned properties and public housing. 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) and units (36%).

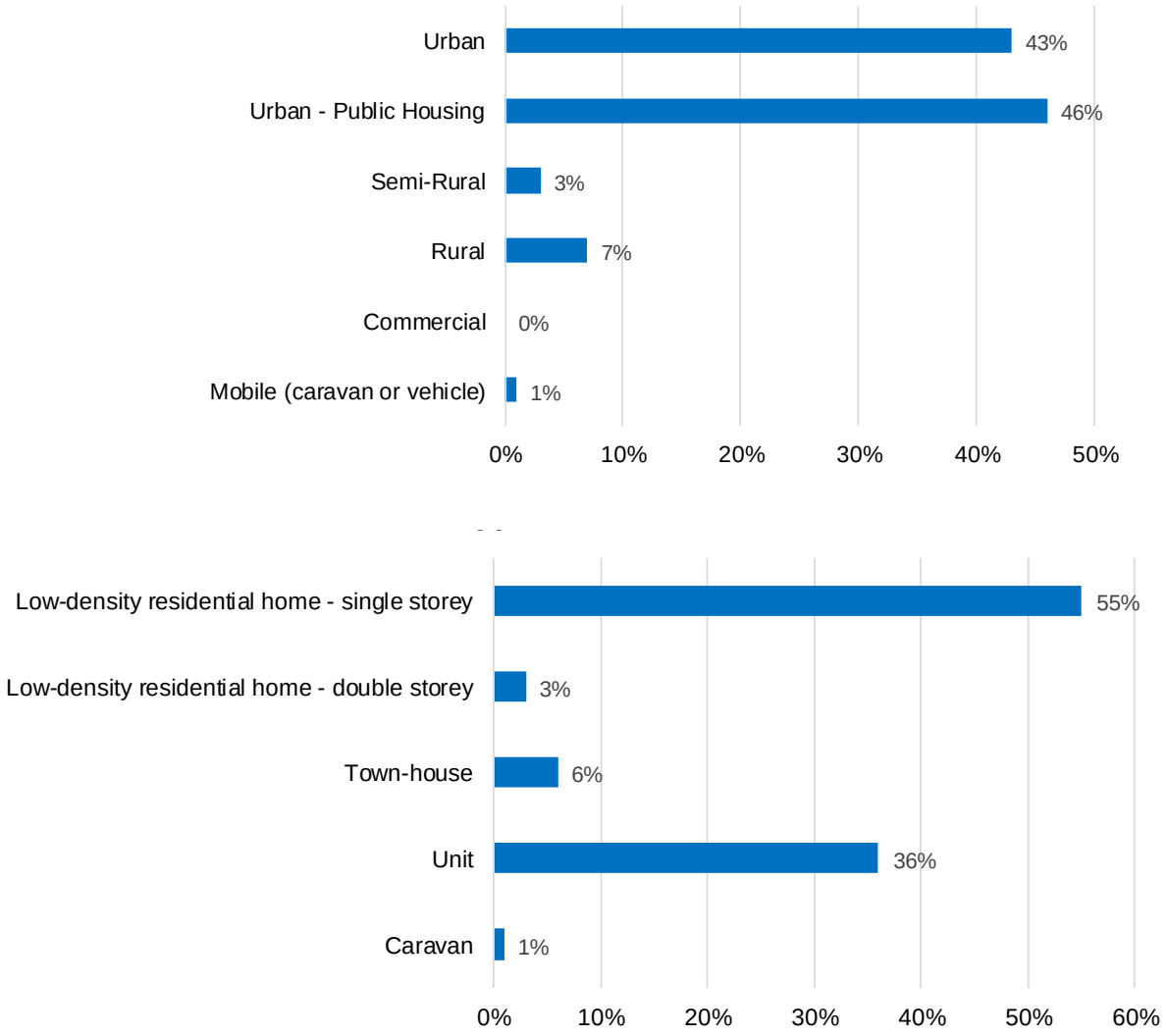


Figure 23 Contamination Data: Type of Properties/Premises

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 hypophosphorus method (which is the most common method in South Australia (2)). 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. **Figure 24** presents a summary of the manufacturing methods relevant to the data included in this study.

It is noted that the manufacturing methods reported, as summarised in **Table 4** are consistent with those reported in the national statistics (2, 25), 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 (indicates as likely to be the P2P method) were all reported from NSW.

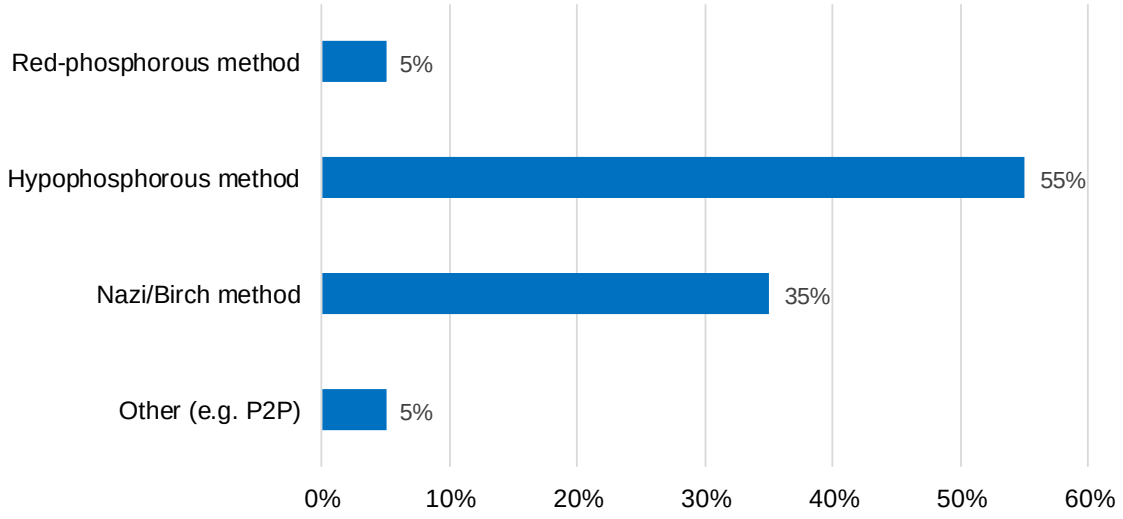


Figure 24 Contamination Data: Manufacturing Methods

Table 4 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

In relation to the location of manufacture at the property, the available data is 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 25** presents a summary of the available information on the location of manufacture. Where the likely location of manufacture is reported, the most common locations are the kitchen and shed/garage.

It is noted that for some properties more than one location is identified, where the following is noted:

- Of the 43 premises where manufacturing occurred in the kitchen, 4 also occurred in the shed/garage, 3 also occurred in the lounge/dining or family room, 2 also occurred in the bathroom or the bedroom, and 1 also occurred the laundry
- Of the 24 premises where manufacturing occurred in the shed/garage, 3 also occurred in the laundry or the bedroom, 1 also occurred in the bathroom and 1 also occurred iiin both the laundry and bedroom
- One of properties was noted to have manufacturing occur in the bathroom, laundry and bedroom.

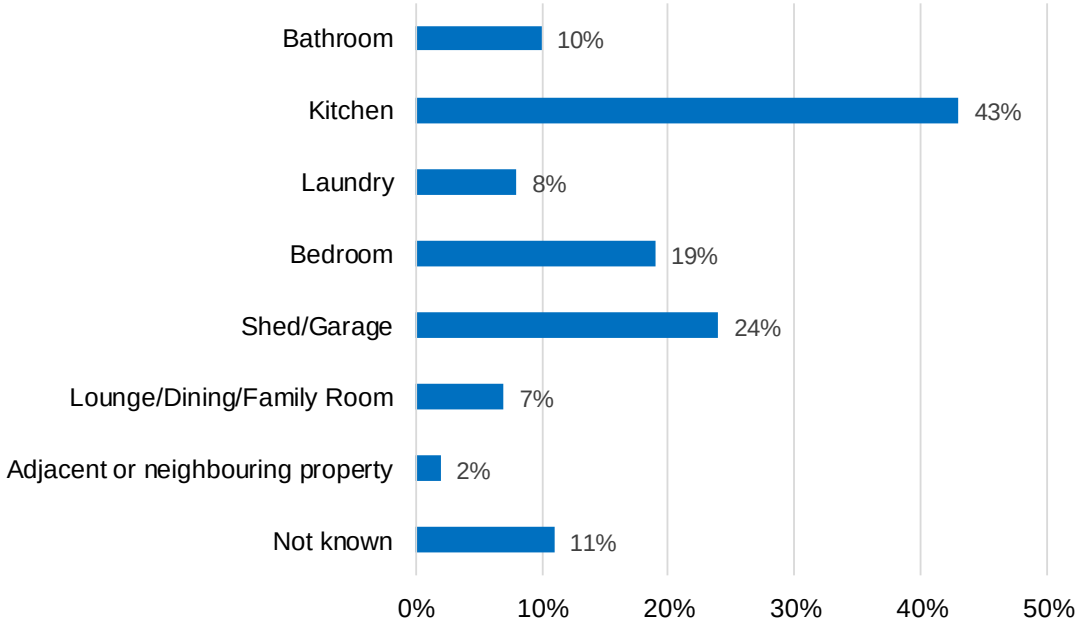


Figure 25 Contamination Data: Likely Location of Manufacture

6.3.3 Preliminary Screening/Tests

Preliminary Screening of WA Premises:

The West Australian approach to the assessment of clandestine drug laboratories incorporates a preliminary screening/assessment step that is undertaken by forensic scientists attending and evaluating the laboratory. The preliminary screening is included on the “Clan Lab Notification Information Checklist” provided by Police to the Environmental Health Officer Emergency Response Team and the Principal Environmental Health Officer for action under the current guidelines (16).

The purpose of the preliminary screening stage is to categorise the clandestine drug laboratory as either Tier 1 or Tier 2. The ranking of the laboratory is based on the manufacture method, the amount of drug produced, the volume of waste stored (which is indicative of the amount of drug produced), the duration of manufacture, the presence of visible staining or contamination and if there was a fire or explosion. The questions/criteria are as outlined in the following extract from the Clan Lab Notification Information Checklist (16).

	QUESTIONS / CRITERIA Where there are any ticks in the Yes column the clan lab type becomes Tier 2	YES	No
1	Are their indications the manufacture method is not a Birch reduction		
2	Is the estimated production cycle capacity > than 5g		
3	Is there > 100L/kg of stored (labeled or unlabeled) chemicals on the property		
4	Is there > 50L/kg of stored waste on the property		
5	Is there visible evidence of significant staining or other surface contamination within the dwelling		
6	Is there evidence or information to suggest long term manufacture		
7	Is there evidence of waste/chemicals being dumped on the property or nearby **(DEC notification)**		
8	Has there been a fire or explosion at the property		
9	Is there any other specific factor at the site which in the opinion of officers (WAPOL or ChemCentre) may potentially pose a risk to public health or the environment (such as a bio-hazard, structural stability or environmental risk)? Comment:		

Where there is any evidence of waste/chemicals being dumped on the property or nearby, notify DEC. ☐

TIER RATING T1 ☐ **OR T2** ☐ Comments if Tier 2:

Figure 26 West Australian Checklist for Identifying Tier 1 or Tier 2 Laboratory (16)

The rating of either a Tier 1 or Tier 2 laboratory relates to the level of risk posed to the public (associated with the level of contamination and spread of contamination) as follows (16):

- Tier 1 clandestine laboratory is one where the “contamination will normally be both limited and low risk”. The remediation of these laboratories is permitted to be undertaken using a straightforward approach as outlined in the Western Australian guidelines. The guidelines do not require detailed assessment of the level of contamination that remains at these laboratories. Hence these premises, when identified, are remediated and no quantitative (or semi-quantitative) contamination or validation data is collected.
- Tier 2 clandestine laboratory is one that should be given “priority attention. These laboratories will require specialised assessment and if necessary, management due to greater risks and more extensive or complicated chemicals processes involved”. For these laboratories a more detailed assessment of contamination that remains at the property is typically undertaken. When obtaining data for use in this study, only data collected from premises rated as Tier 2 laboratories has been included.

The Western Australia Department of Health has provided access to their internal database of clandestine drug laboratories (accessed on 4 December 2014). The database provides details on the information provided by police (as reported on the Clan Lab Notification Information Checklist as well as other observations provided by police in the conduct of their duties) for laboratories reported to the department. The database included information on laboratories reported from 2012. The reporting of information is noted to have improved between 2012 and 2014 as the notification process and reporting process improved and evolved. The database has been reviewed for the financial years (July to June) for 2012/2013 and 2013/2014 where the information summarised in **Table 5** was obtained.

Table 5 Summary of Clandestine Drug Laboratory Information Held by WA Health 2012-2014

	2012/2013	2013/2014
Total number of clandestine laboratories in database	88	66
Tier 1 Labs		
Number reported	59 (67% reported labs)	50 (76% reported labs)
Public housing	5 (8%)	7 (14%)
Bush labs	23 (39%)	20 (40%)
Number where children were reported to be present	14 (24%)	8 (16%)
Tier 2 Labs		
Number reported	29 (33% reported labs)	16 (24% reported labs)
Public housing	1 (3%)	6 (37%)
Number of bush sites	4 (14%)	0
Non-Birch method	4 (14%)	11 (69%)
Number where children were reported to be present	5 (17%)	3 (19%)
Number where fire/explosion occurred	8 (28%)	6 (37%) (included 1 death)

Preliminary tests:

Prior to the collection of quantitative data from the premises a number of investigators undertook preliminary screening. This data has not been collected in all (or even the majority) of the premises included in this study. The preliminary tests typically involved testing pH, volatile organic compounds in air, use of screening tools to determine the presence of iodine, phosphorus, lead and mercury and the used of semi-quantitative screening kits for methamphetamine.

pH:

pH tests have been conducted in 32 of the properties included in this study. The testing undertaken typically targeted areas of staining, as well as sinks and drains (likely locations of waste disposal). The results obtained included the following:

- no evidence of acids or alkalis

- mildly acidic stains (or within the range of the reference water) in the range 5 to 6
- acidic conditions in some locations (common in kitchens, bathrooms, storage areas and stains) where the pH is reported to range from 1 to 4
- alkaline areas (commonly reported on walls, floor, sinks, drains and stains) where the pH is reported to range from 9 to 11

The premises where very low or very high pH levels were reported, associated with the presence of acids and alkalis, also reported elevated levels of methamphetamine residues. It is noted, however that some of the premises where neutral pH was reported also had elevated levels of methamphetamine, hence pH alone is not a good indicator of methamphetamine contamination.

Volatile Organic Compounds (VOCs) in Air:

VOCs in air have been tested using a photo-ionisation detector (PID, model and manufacturer variable depending on the assessment company) at 33 of the properties included in this study. The reporting of VOCs in air using a PID only reports total VOCs in the response range of the PID instrument. It does not provide any information on the individual VOCs present.

At the time when the preliminary testing was undertaken at these properties the following was reported:

- Levels in 17 of the premises (53%) were reported as non-detections. The limit of reporting for these readings was often 1ppm and for these premises a range of methamphetamine contamination levels were reported.
- Levels in 11 premises (31%) were reported using a more sensitive PID instrument, with levels reported below 1 ppm, typically in the range of 30 to 900 ppb. For premises where VOCs were detected in air at levels above background (as measured in ambient air during each assessment), elevated levels of methamphetamine residues were also reported.
- Levels in 5 premises (16%) were reported to have levels in excess of 1ppm. In addition 2 of the locations where low levels were reported in the premises, also reported high levels (in excess of 1ppm) close to containers found to have “unidentified” liquids stored within them. The reported levels include the following:
    - 1 - 4 ppm reported in lounge areas
    - 2 - 8 ppm reported in roof space
    - 3 – 10 ppm reported in chemical storage area (indoors and in shed)
    - 5 - 15 ppm reported near containers with unknown chemicals

  For premises with VOCs reported in excess of 1 ppm, elevated levels of methamphetamine residues were also reported.

XRF:

An XRF (X-ray fluorescence portable instrument, model and manufacturer variable depending on the assessment company) was used at 19 of the premises included in this study. The XRF was used to determine the presence of iodine, phosphorous, lead and mercury on surfaces (where stained areas and potential areas of manufacture were targeted) and in soil (where there was evidence of waste being disposed). No numerical/quantitate value was reported as the instrument was used to determine the presence of absence of these compounds in the areas tested. The testing undertaken using the XRF was on laboratories seized in NSW where the manufacture method was more likely to be the red-phosphorus or hypophosphorus methods. The presence of elevated levels of mercury (and lead) may be associated with the P2P manufacturing method.

The preliminary testing at these premises reported the following:

- No detections reported at 1 of the 19 properties sampled (5%)
- Positive detections for iodine at 18 of the 19 properties sampled (95%). Of these properties the following were also detected:
    - Positive detections of phosphorous in 11 of the properties (61%)
    - Positive detections of mercury in 5 of the properties (28%)
    - Positive detection of lead at 1 property
    - Positive detection for phosphorous and mercury at 1 property
    - Positive detection for mercury and lead at 1 property

Iodine check:

An iodine swab test was undertaken at 8 of the premises included in this study. The iodine was undertaken at premises located in NSW and Victoria where XRF was not undertaken. Of the premises tested, 2 reported detections of iodine above the limit of reporting for the test (10 to 50 µg).

Immunoassay Tests:

Semi-quantitative immunoassay swab tests were undertaken at 51 of the premises included in this study. The immunoassay testing was undertaken for the following purposes:

- As a preliminary test to determine the presence, or absence, of methamphetamine residues on surfaces in areas of likely contamination. These tests typically have a method detection limit that was below the health based criteria to establish the level of contamination present. A preliminary test was conducted at all 51 of the premises tested using this method. Further

testing using wipe sampling and laboratory analysis using GC-MS to obtain quantitative values was undertaken in 15 of these premises.

- As an assessment tool to determine the extent of remediation. Of the 51 premises where preliminary testing was undertaken, 36 of these then only used results from the immune-assay tests to inform decisions in relation to the remediation of the premises. In some cases the dilutions are performed to determine the range of residue levels in the premises.

6.3.4 Quantitative Data - Indoors

The collection of surface swab samples from inside the premises assessed involved sampling 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 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 immune-assay test methods, with the remaining 63 properties characterised using laboratory analysis using GC-MS methods.

It is noted that the code allocated to each of the properties 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 27 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 obtained from immune-assay sampling. 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.

Figure 28 and **Figure 29** present a more detailed summary of the maximum concentrations reported in each area tested and the characteristics of these properties, for each property where quantitative data is available. These figures are separated into properties where the manufacturing method was the Red P/Hypo methods (**Figure 28**) and Birch/Nazi and other (P2P) methods (**Figure 29**). The location of manufacture has been highlighted (in yellow) for each of these premises, where known. This has been included to indicate what is reported or suspected in relation to the manufacture location (which sometimes does not match in with the data) and the spread of contamination in the property.

Table 6 presents a summary of the levels of surface residues reported on properties only evaluated on the basis of semi-quantitative immune-assay testing. The table also includes characteristics relevant to the property.

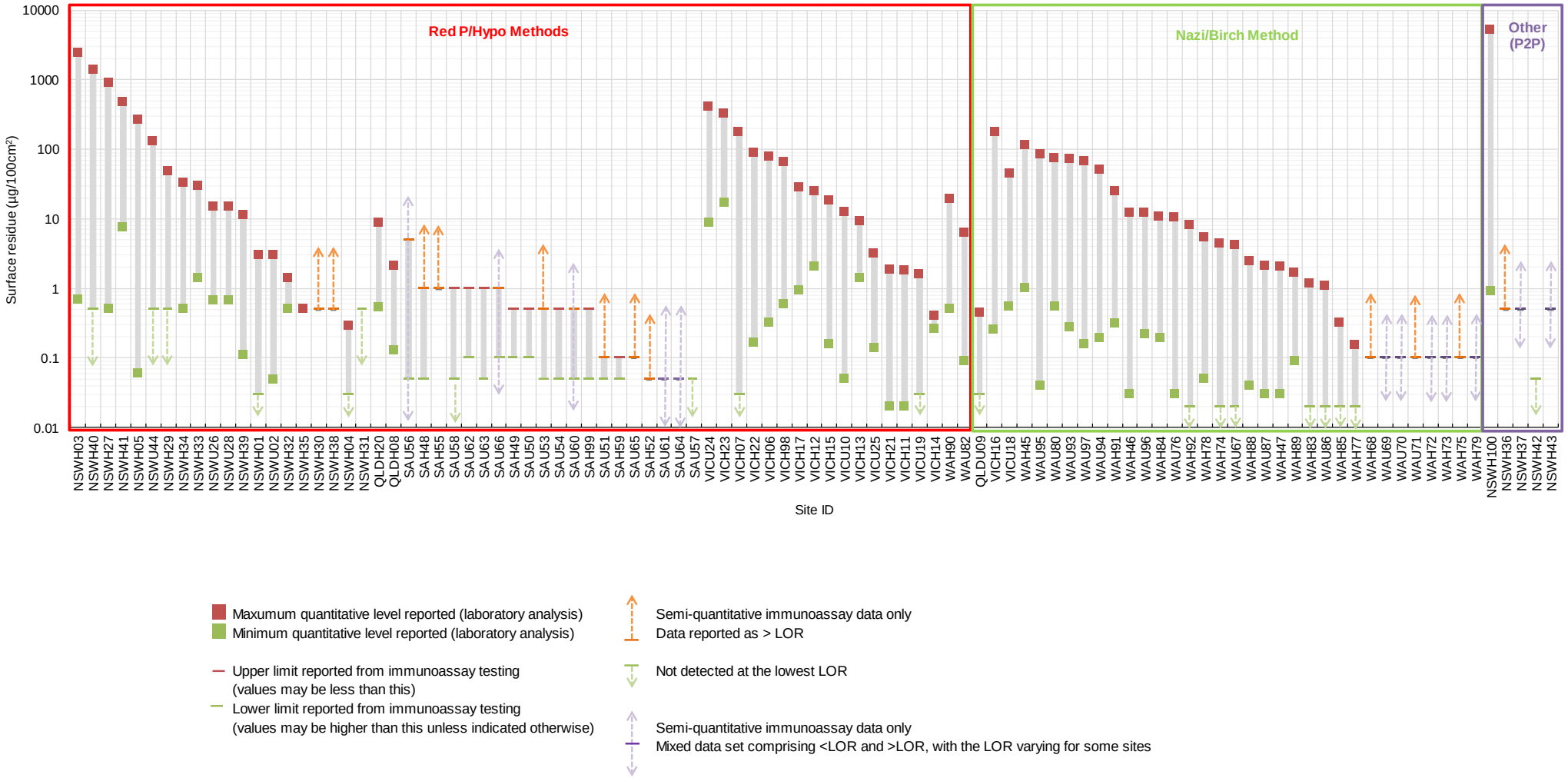


Figure 27 Contamination Data: Range of Methamphetamine Surface Residues Reported Indoors at Each Premises

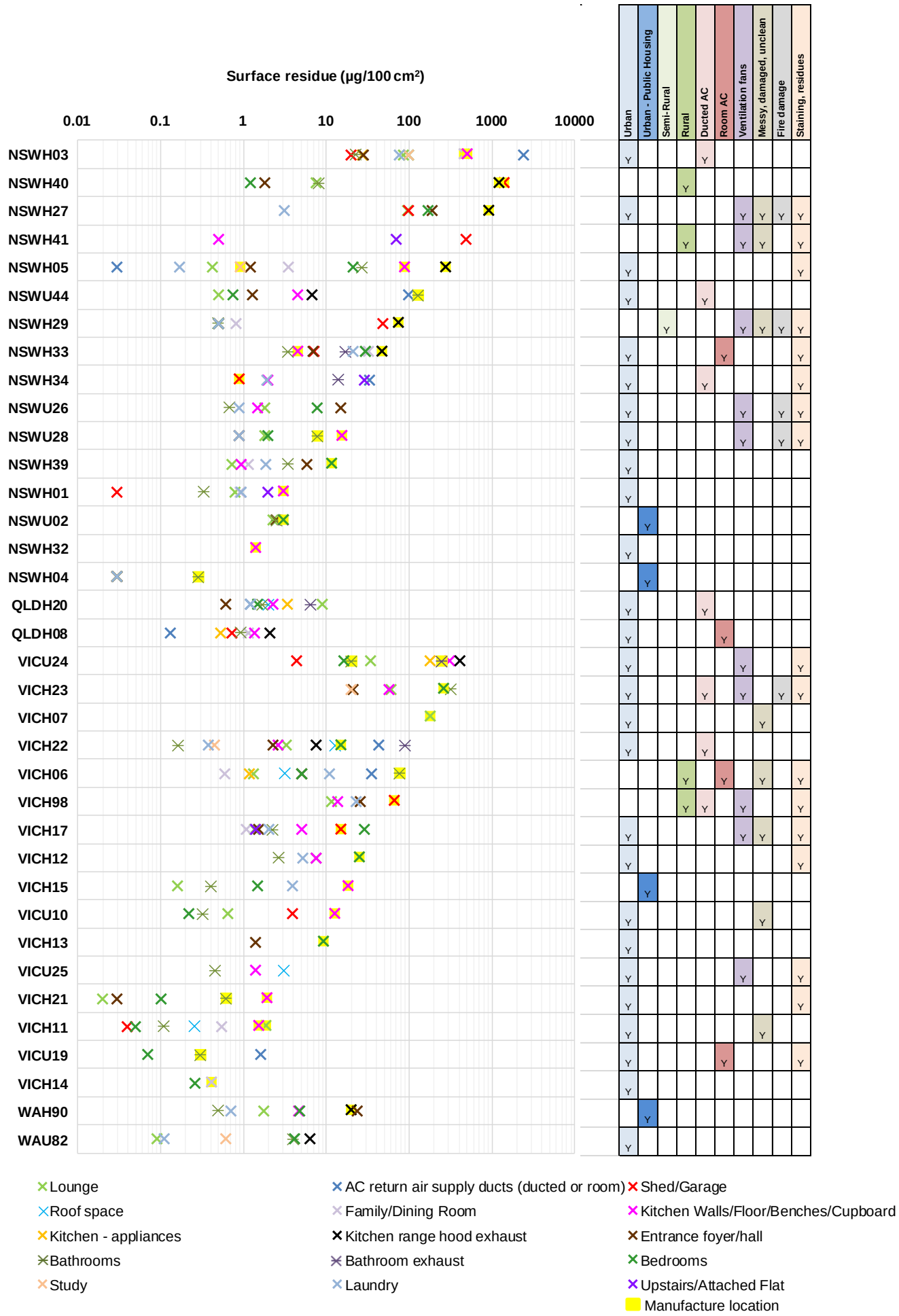


Figure 28 **Summary of Maximum Surface Residues Reported by Area and Property Characteristics: Red P and Hypo Methods**

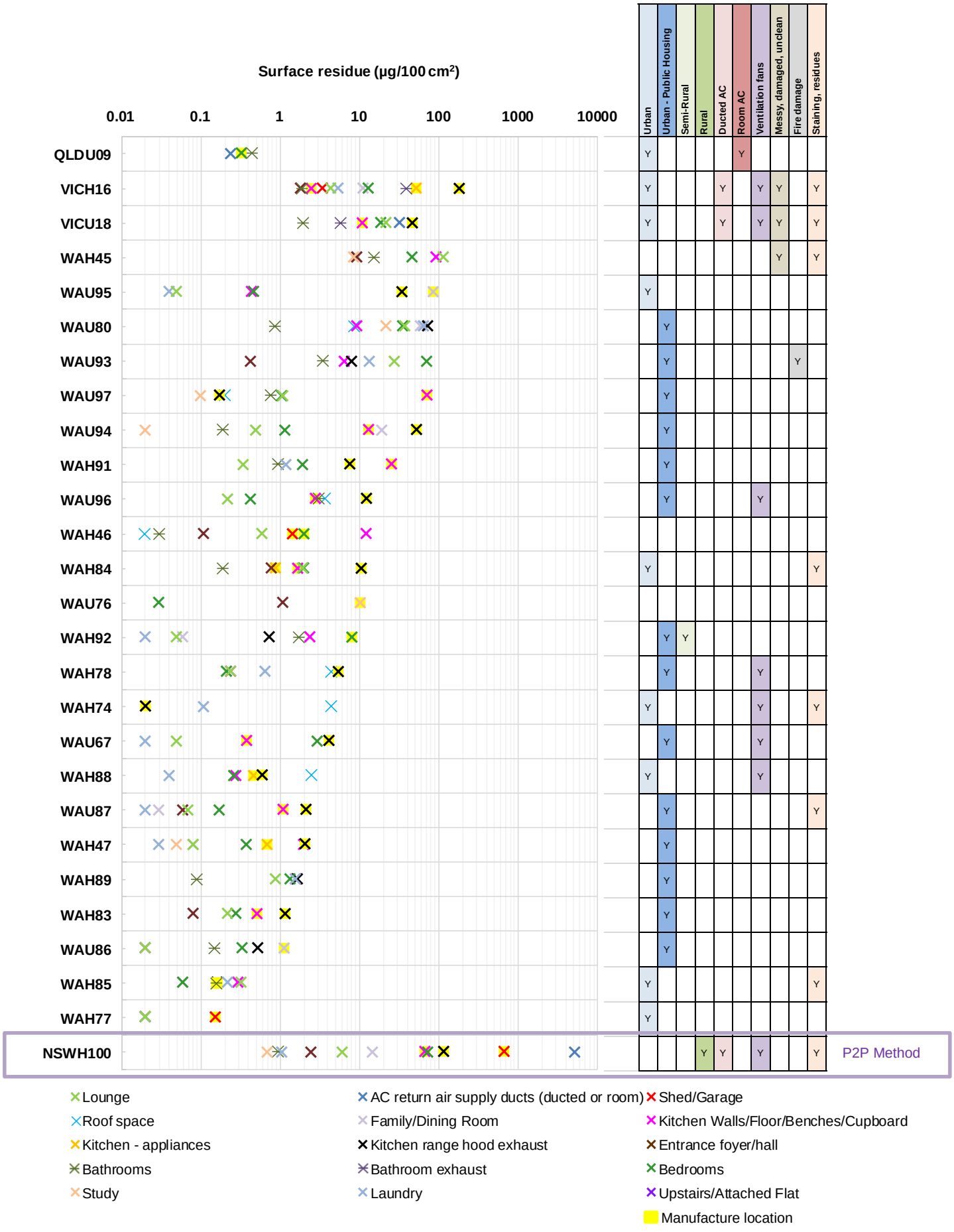


Figure 29 **Summary of Maximum Surface Residues Reported by Area and Property Characteristics: Nazi/Birch and P2P Method**

Table 6 Summary of Semi-Quantitative Data for Methamphetamine Surface Residues

Site ID	Lounge	AC return air supply ducts (ducted or room)	Shed/Garage	Roof space	Family/Dining Room	Kitchen Walls/Floor/Benches/ Cupboard	Kitchen - appliances	Kitchen range hood exhaust	Entrance foyer/hall	Bathrooms	Bathroom exhaust	Bedrooms	Laundry	Urban	Urban - Public Housing	Semi-Rural	Rural	Ducted AC	Room AC	Ventilation fans	Messy, damaged,	Fire damage	Staining, residues
Hyphosphorous method																							
NSWH30			>0.5														Y						Y
NSWH31			<0.5																			Y	
NSWH35			>0.5			>0.5					>0.5					Y				Y			Y
NSWH38			>0.5											Y									
SAH48	>0.05					>0.05				>0.05			>1		Y								
SAH49						>0.1 and <0.5									Y						Y		
SAU50												>0.1 and <0.5			Y								
SAU51					>0.1	>0.05			>0.05						Y						Y		
SAH52						>0.05									Y						Y		
SAU53						>0.5				>0.05		>0.05			Y								
SAU54	<0.05									<0.05		>0.1 and <0.5			Y								
SAH55						>1									Y						Y		Y
SAU56						>5		>0.5		<0.05		<0.05			Y								
SAU57						<0.05				<0.05		<0.05			Y						Y		
SAU58	>0.05 and <1					>0.05 and <1	>0.05		>0.05	<0.05		>0.05			Y						Y		
SAH59	<0.05					>0.05 and <0.1						<0.05	<0.05		Y						Y		
SAU60						>0.5				<0.05		>0.5			Y						Y		
SAU61	>0.05					>0.05	>0.05					<0.05			Y							Y	

Site ID	Lounge	AC return air supply ducts (ducted or room)	Shed/Garage	Roof space	Family/Dining Room	Kitchen Walls/Floor/Benches/ Cupboard	Kitchen - appliances	Kitchen range hood exhaust	Entrance foyer/hall	Bathrooms	Bathroom exhaust	Bedrooms	Laundry	Urban	Urban - Public Housing	Semi-Rural	Rural	Ducted AC	Room AC	Ventilation fans	Messy, damaged,	Fire damage	Staining, residues
SAU62				>0.1 and <0.5		>0.5 and <1	>0.1 and <0.5			>0.5 and <1		>0.5 and <1			Y								
SAU63	>0.05	>0.05	>0.05		>0.05	>0.05 and <1	>0.05		>0.05	>0.05 and <1		<0.05			Y			Y			Y		
SAU64			>0.05		<0.05	<0.05						>0.05			Y								
SAU65						>0.1						>0.1	>0.1		Y						Y		
SAU66					>0.1	>1			<0.1			>0.05			Y								
SAH99	<0.05				<0.05	>0.05 and <0.5		>0.05 and <0.5		<0.05			>0.05 and <0.5		Y						Y		
Nazi/Birch Method																							
WAH68					>0.1	>0.1				>0.1		>0.1	>0.1		Y							Y	
WAU69						<0.1	>0.1	>0.1				>0.1			Y								Y
WAU70	>0.1					<0.1	>0.1			<0.1		>0.1			Y						Y		
WAU71	>0.1							>0.1				>0.1			Y						Y		
WAH72	>0.1					<0.1						<0.1	>0.1	Y							Y		
WAH73	>0.1					>0.1			>0.1			<0.1	<0.1		Y								Y
WAH75			>0.1			>0.1						>0.1			Y						Y		Y
WAH79	<0.1				>0.1	>0.1				<0.1		<0.1	<0.1		Y						Y		
P2P Method																							
NSWH36			>0.5			>0.5				>0.5				Y						Y			
NSWH37	<0.5		>0.5											Y									
NSWH43			>0.5			>0.5			>0.5	>0.5		>0.5	<0.5				Y						

>0.5	Known or suspected location of manufacture
>0.5	Concentration exceeds test cut-off
<0.5	Concentration is less than the test cut-off

Figure 30 presents a summary of the maximum concentrations reported (i.e. quantitative data) from key locations in all premises on the basis of the reported method of manufacture.

It is noted that for the other manufacturing methods (likely to be P2P) all but one of these laboratories were evaluated on the basis of semi-quantitative immunoassay testing only and hence the quantitative data is limited for these premises.

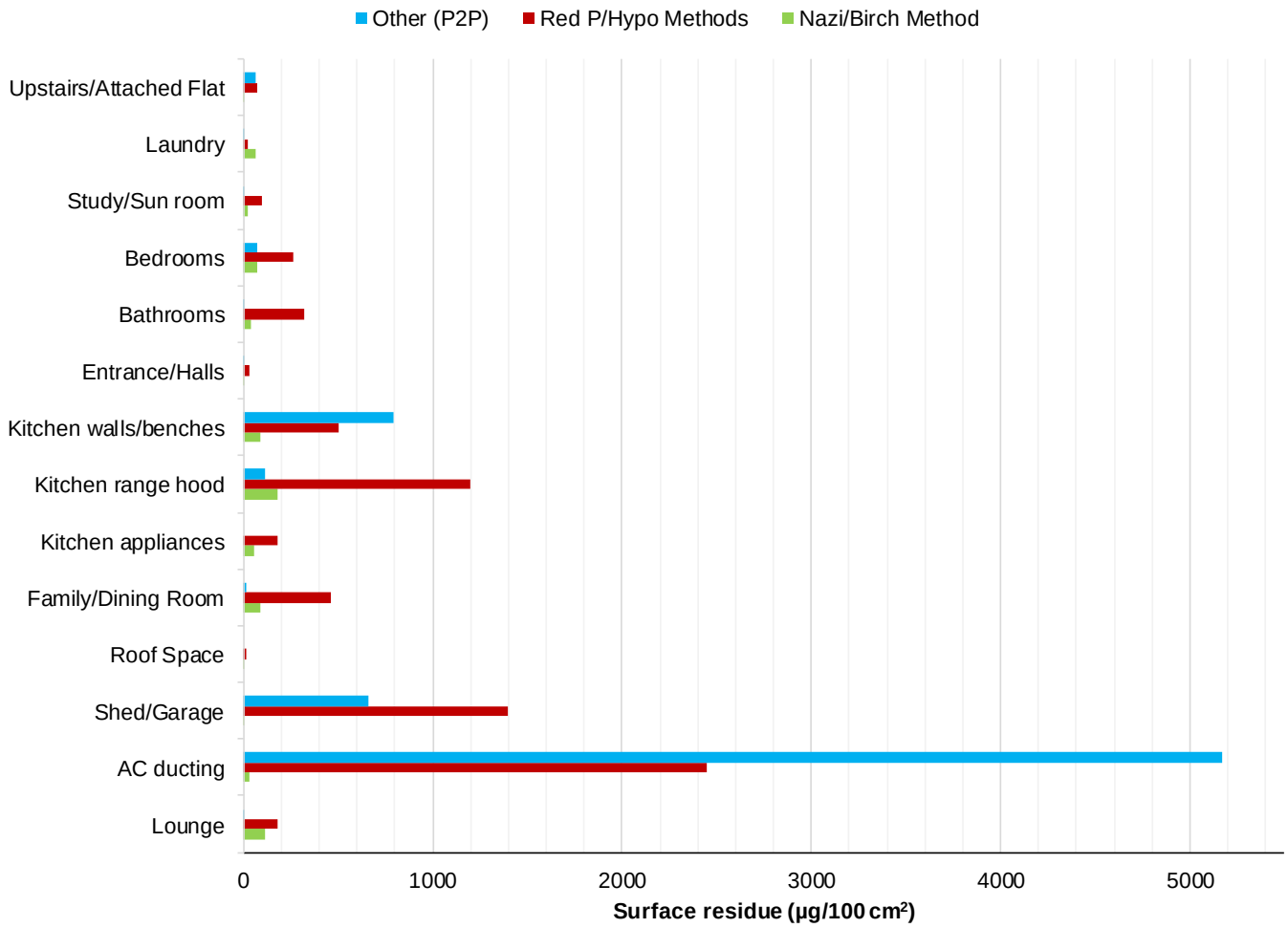


Figure 30 **Contamination Data: Maximum Methamphetamine Surface Residues Detected in Different Areas of a Property (by Manufacture Method)**

The available data supports that (in general) residues that remain following manufacture using the red-phosphorus or hypophosphorus methods (and in some cases the P2P method) are higher than from the Nazi/Birch method. The data from laboratories in Western Australia for the Nazi/Birch method are known to be those where a larger quantity of drugs may have been manufactured. This is due to the tiered screening approach adopted in Western Australia (as outlined in **Section 6.3.3**) were lower level risk laboratories where small quantities may have been manufactured were not tested and included in this study.

The data indicates that the location with the most significant contamination is where manufacture occurred, or is suspected to have occurred. Some of the locations with the highest reported levels of contamination are air conditioning ducts, sheds/garages and kitchen ventilation systems.

Contamination in air conditioning ducts and ventilation system have the potential to result in the spread of contamination throughout a premises and the re-distribution of methamphetamine contamination in air during occupation of the property. 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.

In relation to direct contact exposures, contamination on surfaces that are directly and regularly accessible is more relevant. The following presents a summary of the maximum methamphetamine surface residues detected inside a premises (i.e. excluding the shed/garage where less frequent direct contact exposures occur with comparison to inside a home) from surfaces that are considered to be accessible. These are surfaces that adults or children may regularly touch during normal daily activities.

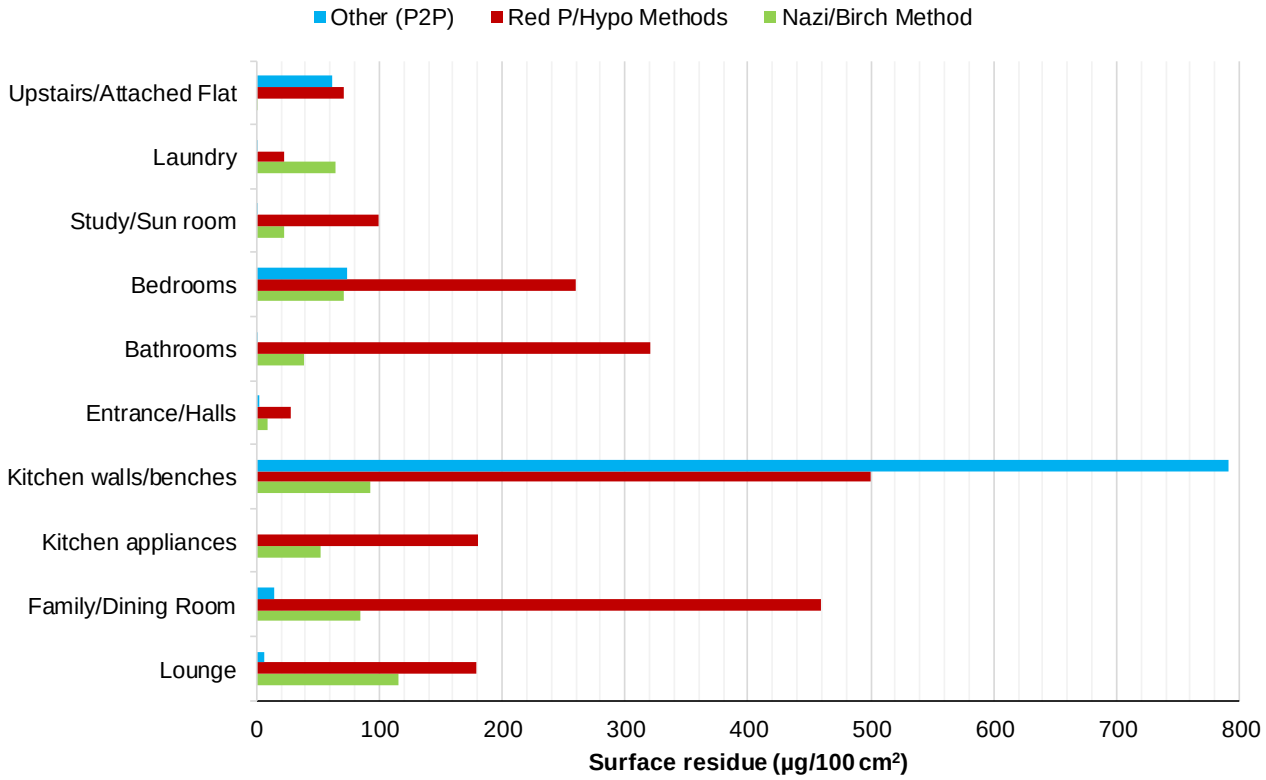


Figure 31 **Contamination Data: Maximum Methamphetamine Surface Residues Detected on Accessible Surfaces within a Property (by Manufacture Method)**

Table 7 presents the breakdown of the range of concentrations reported in hard surfaces in the homes evaluated in this study, with comparison against the range of concentrations reported in the literature in premises following seizure by police or following manufacture.

Table 7 Summary and Comparison of Methamphetamine Surface Residues on Hard Surfaces in Homes

Location/Activity	Range of Maximum Methamphetamine Surface Residue Reported (µg/100 cm^2)	References
Data from Australian Premises Reported in This Study (following seizure and assessment by Police, prior to remediation) (various methods)		
Walls and surfaces within: kitchen including benches dining/family room lounge room bedrooms bathrooms entrance hall/foyer study/sun-room laundry upstairs (ground floor used for manufacture) shed/garage	 0.05 to 791 0.03 to 460 0.02 to 179 0.02 to 260 0.03 to 320 0.03 to 27.7 0.05 to 100 0.03 to 65 0.09 to 71 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)	
Data from Seized and Suspected Laboratories (cook methods not specified)		
Walls and surfaces that include benches, tables, floors, indoor fans, appliances	0.1 to 6093 to 16000 after explosion	(36, 47, 51, 157)
Ventilation and fans (including kitchen range hood)	0.2 to 450	(36)
Kitchen Appliances (microwaves, burners, ovens, refrigerators	nd to 16000	(36)
Data from Controlled Cooks - Red phosphorous, hypophosphorous and anhydrous methods		
Various surfaces	0.08 to 860	(36, 38, 39, 44, 47, 50)

nd = not detected (variable analytical limits or reporting)

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 (as listed in **Table 7**). Some higher residue levels of contamination have been reported in former clandestine drug laboratories in the US, however it is noted that the maximum residue levels reported for these premises are from stained areas on the ceiling and inside microwave ovens (used for cooking), neither of which were evaluated in any of the Australian premises included in this study.

Table 7 has summarised data from two properties that were not used for manufacture, a unit and detached granny flat (guest house). However, these properties were neighbouring another unit or home where manufacture using the hypophosphorous and P2P methods had occurred. For the

neighbouring units, located on the same floor in a unit block, methamphetamine reside levels reported in the unit used for manufacture ranged from 4.4 to 406 µg/100 cm^2 while the levels reported in the adjacent unit ranged from 0.14 to 3.1 µg/100 cm^2. For these units the maximum levels reported in the neighbouring unit were 0.7% of that in the unit used for manufacture. The units did not have any shared air conditioning or ventilation systems, only individual fans in the bathrooms that vented into the common roof space. No other units within the building were tested for methamphetamine contamination. For the detached granny flat, methamphetamine reside levels reported in the unit used for manufacture ranged from 7.7 to 490 µg/100 cm^2 while the levels reported in the adjacent granny flat were reported to be <0.5 µg/100 cm^2, i.e. not detected above 0.5 µg/100 cm^2.

It is noted that data summarised in **Table 7** includes a number of areas where the range of methamphetamine surface residues varies significantly, in some cases in the order of 10,000. This is particularly evident for the data reported within ventilation systems and fans, sheds and garages as well as the walls and surfaces in the kitchen, dining, bathrooms and bedrooms. Where the data from individual properties are considered, as presented in **Figures 27 and 28**, the variability in methamphetamine surface residues ranges from 10 to >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 **Figures 27 and 28** indicate that where known, the likely location of manufacture is generally associated with higher levels of methamphetamine surface residues. 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.

To obtain a better breakdown of the surface residue levels reported in the premises included in this study the maximum levels reported has been used to group the premises into specific ranges of residue levels. This allows for inclusion of data from both the quantitative analysis as well as the immune-assay testing (for premises where the method has been used to determine a range). Where the immune-assay testing has determined that the surface residue levels are greater than a test reporting level (i.e. insufficient information is available to determine the range of residue levels), these data have not been incorporated into this analysis.

The ranges selected for this review start at the criteria established (13) for residential surfaces of 0.5 µg/100 cm^2 and increase by orders of magnitude:

- Less than the guideline: ≤0.5 µg/100 cm^2
- Low level contamination: >0.5 and ≤5 µg/100 cm^2 (i.e. up to 10 times greater than the guideline)

- Moderate to high level contamination: >5 and ≤50 µg/100 cm^2 (i.e. between 10 and 100 times greater than the guideline)
- High to very high level contamination: >50 to ≤500 µg/100 cm^2 (i.e. between 100 and 1000 times greater than the guideline)
- Very high level contamination: >500 µg/100 cm^2 (i.e. more than 1000 times higher than the guideline)

Figure 32 presents a summary of the number of premises where the maximum surface residue levels reported fall within the above ranges on the basis of the reported method of manufacture.

Of note is that 85% of the properties tested reported methamphetamine surface residues that exceeded the residential criteria of 0.5 µg/100 cm^2, 56% of the properties exceeded 10 times the residential guideline, 28% of the properties exceeded 100 times the guideline and 5% of the properties exceeded 1000 times the guideline.

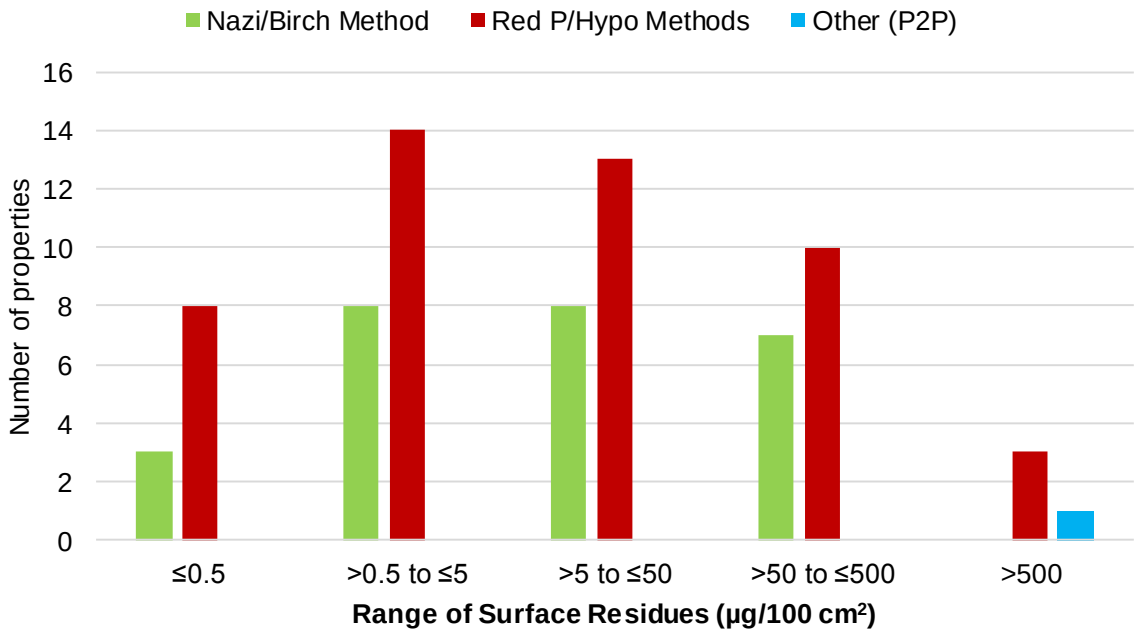


Figure 32 **Contamination Data: Number of Properties with Methamphetamine Surface Residue Contamination at Different Levels, by Manufacture Method**

Of the premises included in this study, 17 included quantitative analysis for pseudoephedrine and ephedrine. Of these, 8 tested positive for the presence of pseudoephedrine and ephedrine. The majority of these premises had methamphetamine contamination that was considered to be moderate to very high, in the range >5 and ≤50 µg/100 cm^2 and >50 to ≤500 µg/100 cm^2.

In addition further review has been undertaken to evaluate the following:

- Property observations: the potential influence of the presence of air conditioning (room or ducted), roof space ventilation, former fire or explosion and evidence of poor chemical storage/handling (i.e. staining/powder residues and messy premises) on the level of contamination in the premises is indicated **Figure 33**. It is noted that information on these aspects was not available for all the premises included in this study and where this information was available it was subjective, depending on the observations provided by the individual assessor.
- Location of manufacture (or likely location of manufacture): whether this affects the generation of different levels of contamination in a property, as shown in **Figure 34**.

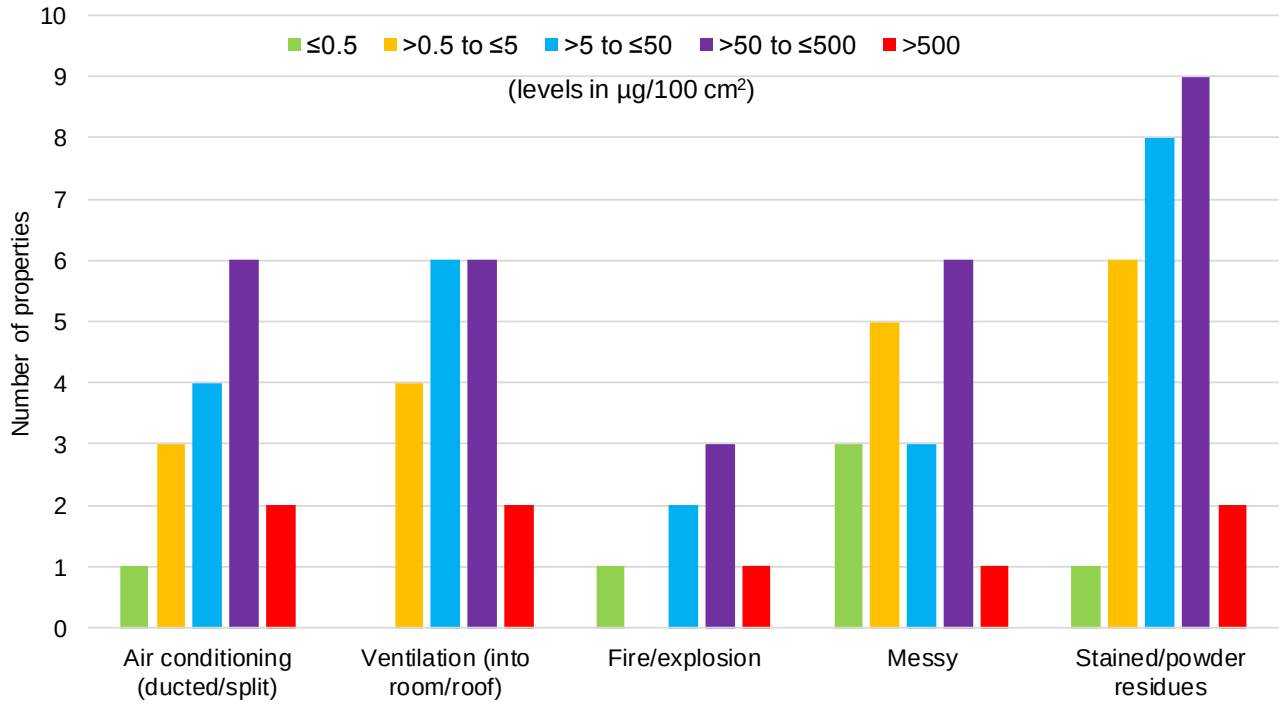


Figure 33 **Contamination Data: Number of Properties with Methamphetamine Surface Residue Contamination at Different Levels, by Property Characteristics Observations**

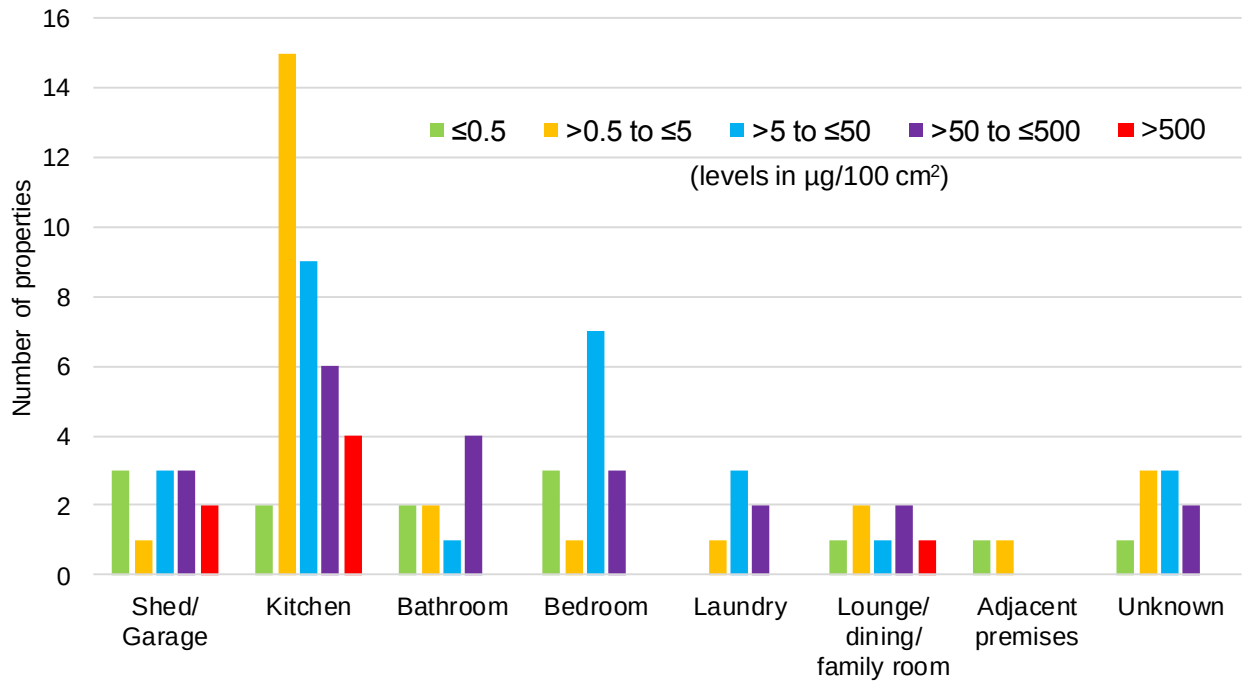


Figure 34 **Contamination Data: Number of Properties with Surface Residue Contamination at Different Levels, by Location of Manufacture**

Review of **Figures 33 and 34** indicates the following:

- There are no distinct property characteristics/ observations that are associated with higher levels of contamination in a home. The presence of ventilation appears to be associated with contamination levels that are higher than for the other property characteristics.
- In general the location of manufacture do not appear to be specifically associated with either low or high levels of contamination in a property. However it is noted that the highest levels of contamination are reported where manufacture occurred in the kitchen, shed/garage or lounge/dining room areas.

Spread of Contamination

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.

Hence qualitative descriptors have been used to categorise the contamination in a property as:

- **Localised** to known or likely location of manufacture (where the maximum levels of contamination are only reported in these locations, with very low levels or levels that are not detected by the analytical method adopted in locations away from these areas)
- **Some spread** of contamination from the known or likely location of manufacture (where the maximum levels of contamination are reported in known/likely locations of manufacture with lower levels reported in some other (but not necessarily all) locations in the premises)
- **Wide-spread** levels of contamination from the known or likely location of manufacture (where contamination has been reported, at various levels, at all locations sampled). The contamination may be considered wide-spread regardless on the level of surface residues reported.

The following figures present a summary of the spread of contamination in the premises included in this study based on:

- the method of manufacture, **Figure 35**;
- property characteristics and observations, **Figure 36** - including the presence of air conditioning (room or ducted), roof space ventilation and evidence of poor chemical storage/handling (i.e. staining/powder residues and messy premises) on the spread of contamination in the premises. It is noted that information on these aspects was not available for all the premises included in this study; and
- location of the manufacture, **Figure 37**.

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.

The property characteristics/observations inside an individual home (**Figure 36)** appear to have an influence on the spread of contamination than the location of manufacture (**Figure 37**). The presence of air conditioning, ventilation, a former fire/explosion and the presence of staining and residues appear to be associated with some to wide spread contamination within a property. Observations of whether a home is messy appears to be less clearly related to the spread of contamination in a property. Where the location of manufacture is considered, manufacturing in the laundry and lounge/dining room areas are associated with some or wide spread contamination.

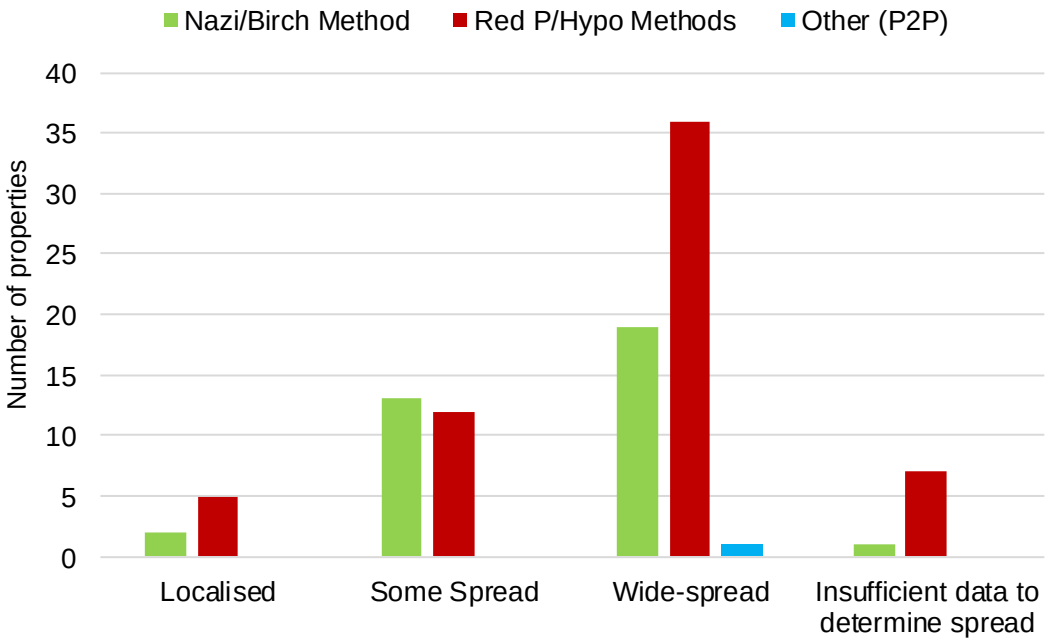


Figure 35 **Contamination Data: Spread of Methamphetamine Residues within Premises, by Manufacture Method**

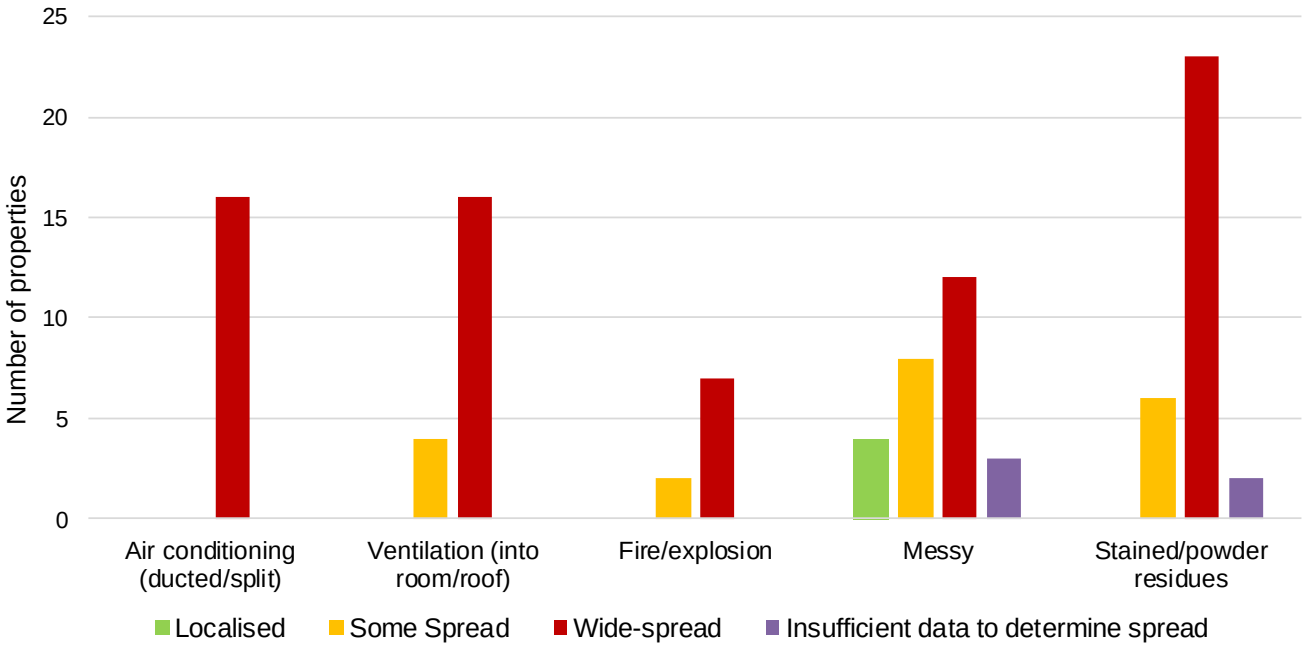


Figure 36 **Contamination Data: Spread of Methamphetamine Residues within Premises, by Property Characteristics Observations**

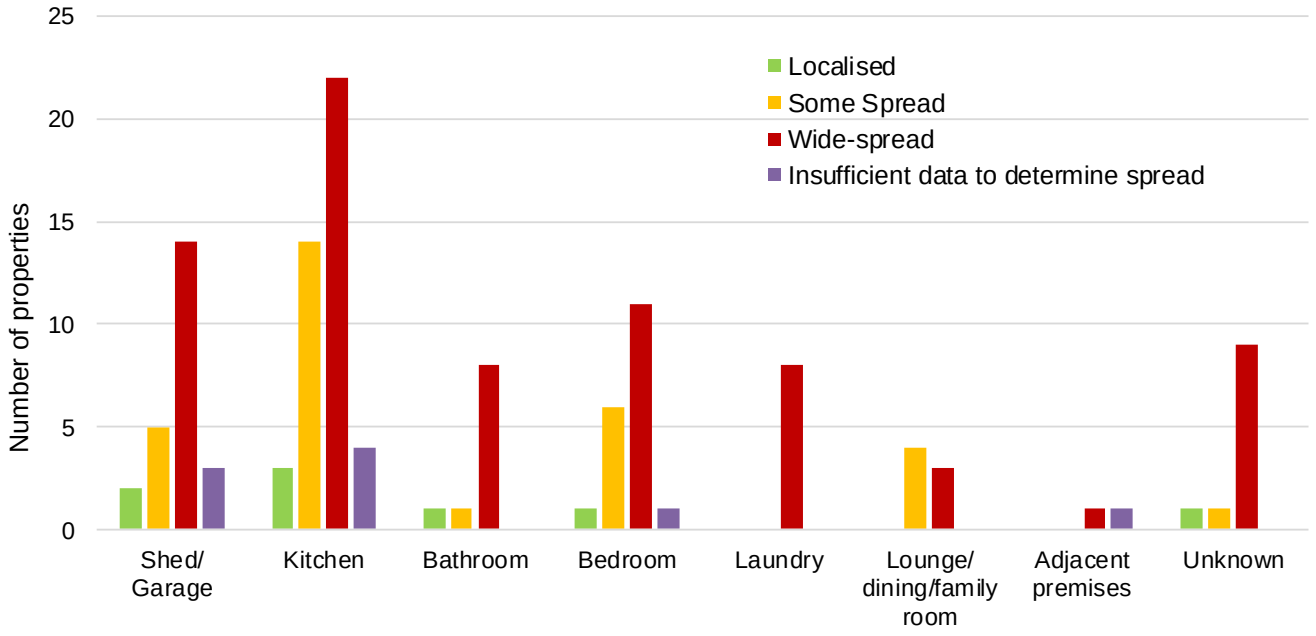


Figure 37 **Contamination Data: Spread of Methamphetamine Residues within Premises, by Manufacture Location**

6.3.5 Quantitative Data – Outdoors

Of the 100 premises included in this study, four included the testing of contamination in septic tanks. These properties were rural properties where the following was reported:

- Methamphetamine was reported at a concentration of 1.5 µg/g in a septic tank located in rural Victoria (VICH06) where manufacture was reported to have occurred via the hypo method. Significantly elevated concentrations of methamphetamine surface residues were reported within the premises (0.33 to 77.3 µg/100 cm^2) and on the external drain pipe (0.468 3 µg/100 cm^2). The premises was stained and there were a number of alkaline (pH 11-12) and acidic (pH 1-3) areas in the premises. At this premises there was evidence of a burn pit outside.
- Methamphetamine, lead, mercury and petroleum hydrocarbons were detected (not quantified) in a septic tank and overflow tanks located on a semi-rural property in NSW (NSWH35) where the manufacturing was reported to have occurred via the hypo method, with a note that other methods were also experimented with. The property was only evaluated using the semi-quantitative immunoassay tests (all samples reported to be >0.5 µg/100 cm^2). Manufacture occurred in the shed where soil was also noted to be contaminated with mercury and iodine by XRF screening.
- Methamphetamine was detected (not quantified) in drains and a septic tank at a rural property in NSW (NSWH100) where the P2P method was used. Sampling also reported detections of methamphetamine in soil.

- Testing of a septic system used by a caravan where methamphetamine was manufactured in NSW did not detect methamphetamine.

Of the 100 premises included in this study, 17 included testing of soil for contamination associated with the manufacture of methamphetamine. The available data is summarised below:

- Testing of a burn-pit outside a rural premises in Victoria (VICH06), where testing of the septic system was also undertaken, did not detect methamphetamine concentrations above 0.03 mg/kg.
- Testing of soil from an urban premises in Queensland (QLDH08) where indoor surface residues ranged from 0.13 to 2.13 µg/100 cm^2 reported concentrations of methamphetamine that ranged from <0.002 mg/kg to 0.013 mg/kg.
- Testing of a soil outside an urban premises in NSW (NSWH03) where indoor surface residues ranged from 0.7 to 2450 µg/100 cm^2 did not detect methamphetamine concentrations above 5 mg/kg.
- Testing of soil at a rural property in NSW (NSWH41) reported methamphetamine concentration of 11 mg/kg and detections (not-quantified) of ethylbenzene, xylenes, isopropylbenzene and total petroleum hydrocarbons. Soil screening (using an XRF) reported positive detections for iodine in soil. Manufacture at this property was reported to have occurred via the Red-P method where indoor surface residues ranged from 7.7 to 490 µg/100 cm^2.
- Testing of a soil outside a rural premises in NSW (NSWH100) (where indoor surface residues ranged from 0.91 to 5171 µg/100 cm^2) detected methamphetamine in soil at concentrations up to 0.64 mg/kg.
- Testing of soil from 6 properties in NSW reported concentrations of methamphetamine, pseudoephedrine/ephedrine and MDMA below the soil criteria presented in the ACC remediation guidelines (13). The quantitative results from these samples were not provided, however all were residential properties where the guidelines are: methamphetamine = 5 mg/kg; pseudoephedrine/ephedrine = 6000 mg/kg; and MDMA = 60 mg/kg. A number of these properties reported positive detections, using XRF, for iodine, phosphorus and mercury in soil.
- Six properties were only tested using an XRF screening tool, For these properties positive detections were reported for iodine (all 6 properties), phosphorus (3 properties) and mercury (3 properties). The areas tested included burn-pits, areas where grass or other vegetation would not grow and other suspected waste dump pits.

6.4 Overview of Environmental Data

Quantitative data in relation to the level of contamination that may remain within a property has been obtained from a number of different assessment and remediation companies. Data has been obtained from 100 properties. This is considered to be sufficient to enable an assessment of contamination in homes where methamphetamine has been manufactured using the more common methods in Australia.

As the data has been obtained from a range of different sources the data is highly dependent on the sampling locations, sampling protocols, analysis methods and observations adopted by each company. This has resulted in a data set that is of mixed quality. However the data is 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 indicates the contamination has spread throughout the home.

It is noted that information and observations provided on the property are subjective and variable particularly in relation to the amount of information provided and the type of descriptions. This is a limitation in reviewing and evaluating the characteristics and observations within a property that may be associated with higher levels of contamination and/or a higher potential for the spread of contamination.

The data, however, have been found to provide indicators of the level of contamination and qualitative observations and characteristics of a property.

The data obtained generally correlates with information provided in interview data in relation to the likely location of manufacture, with the kitchen, shed/garage, bedroom and bathroom the most common locations. The environmental data collated indicates the potential presence of a wide range of methamphetamine surface residue levels inside a property. The level and spread of contamination is specific to each individual property. The individual characteristics and observations of a property that has been used for the manufacture of methamphetamine has been considered further to develop a tool for conducting a preliminary ranking of risk. This is detailed further in **Section 10**.

7.0 COLLECTION OF DATA TO CHARACTERISE EXPOSURES BY POLICE

7.1 Purpose

Police seizing and investigating ATS premises (active or inactive laboratories) have the potential to be exposed to chemicals and residues if they are not properly protected using PPE. Current procedures within drug related policing units treat clandestine drug laboratories as hazardous workplaces and require all personnel to wear PPE appropriate for the hazards identified.

Hair samples have been collected from police to determine if any of these individuals have been exposed to ATS during the course of their duties. The data also provides information on the effectiveness of the PPE used.

7.2 Data Collection Methods

Ethics approval to conduct the interviews was obtained from the Southern Adelaide Clinical Human Research Ethics Committee (Application 477.11).

Permission was obtained from WA Police to include police within the drug unit in this study. Only individuals who provided informed consent were included in the study.

Participants in the study completed a short questionnaire (included in **Appendix B**) that related to how long they have been involved in investigating ATS drug laboratories, if (and how) they have been exposed to chemicals at a laboratory, if they were wearing PPE when exposed, if they experienced any health effects when exposed and if these health effects required treatment.

Participants consented to the collection of hair samples for analysis. The hair samples were collected by the researcher in general accordance with the hair sampling procedure provided by Forensic Science SA. This involved the following:

1. Cutting of hair from the crown or vertex of the head. The hair is cut using clean sharp scissors from as close to the scalp as possible. Where possible the hair sampled was approximately the thickness of a pencil. Where the hair was thin or short, hair was sampled from more than 1 location on the crown/vertex to maximise the amount of hair sampled.
2. The hair sample was placed on aluminium foil with the cut end (root end) noted. The foil was wrapped around the hair sample (without folding the hair itself). The outside of the wrapped foil was then marked as to which end was the cut/root end. Where the hair sampled was short (approximately 1cm in length) it was not possible to line up or mark the cut/root end of the sample collected.

3. The hair sample was then placed into a clean zip-lock bag. The sample was given a unique identifying code (based on the gender and hair colour of the participant). The sample ID was marked on the zip-lock bag.
4. The samples were securely stored at room temperature prior to analysis.

7.3 Analytical Methods

The hair samples were analysed for methamphetamine and amphetamine by Forensic Science SA. The method involves extraction using methanol and analysis using liquid chromatography with tandem mass spectrometry (LC-MS/MS) using an electrospray ionisation (ESI) source.

Preparation and Extraction

An approximate 3cm segment of hair (cut from the end closest to the scalp/root) is cut into segments from 1-5mm in length and 20 mg is transferred into a glass tube. Any environmental (external) contamination of the sample is removed by a brief (approximately 30 seconds) wash with 2 mL methanol. The methanol wash is analysed separately.

Internal standard (d^5-methylamphetamine for methylamphetamine and d^5-amphetamine for amphetamine) is added and extraction of the drugs from the sample is achieved by incubating overnight (approximately 18 hours) at 45 ^oC in 2 mL methanol. Following extraction the sample is allowed to cool to room temperature and the methanol transferred via pipette to a disposable test tube. Acid alcohol (20 µL of 0.5% hydrochloric acid in methanol) is added to form the hydrochloride salt of the amphetamines prior to solvent evaporation under a steady stream of nitrogen at 40 ^oC. This ensures amphetamines are not lost at the evaporation stage.

The residue is reconstituted with 100 µL of 0.1% formic acid to match the mobile phase and ensure satisfactory chromatographic peak shapes and separation. The samples are transferred to a 2 mL vial, capped and centrifuged for 5 minutes.

Analysis

The extract is analysed by LC-MS/MS using an ESI source. The instrument used is an Agilent 1200 LC system with Applied Biosystems 4000Q-Trap MS. The column is a Phenomenex Luna PFP(2) 3 µm 50x4.6 mm with PFP guard column 5 µm 4 x 2.0 mm.

Deuterated analogues of the drugs to be quantified are used as internal standards. A blank and quality control samples (purchased commercial external hair controls and a previous drug-positive proficiency case sample) are included with batch run. Calibration curves are constructed and used to calculate the drug concentrations in the samples.

The sensitivity of the instruments enables the identification and quantification of trace levels of drugs, with a quantitation limit of 5 pg drug per mg hair (pg/mg) for amphetamines. While it is

common for the reporting of drugs in hair to include a reporting limit (to remove low level detections that may be the result of prescribed medications or low level instrument error) the analysis undertaken for this study has requested all trace level detections be quantified as none of the participants are drug users.

7.4 Results

Informed consent was obtained from 10 individuals, 9 male and 1 female police officer within WA Police. The age of participants range from 30 to 42 (average age of 37 years). The following tables summarise the information collected from the participants.

Table 8 Summary of Participant Information

Sample ID	Age	Gender	Hair Colour
WPMB01	42	male	Brown
WPMBL02	43	male	Black
WPMGR03	41	male	Grey
WPFBL04	40	female	Blond
WPMBL05	35	male	Black
WPMBL06	37	male	Black
WPMLB07	30	male	Light brown
WPMBL08	42	male	Black
WPMDB09	29	male	Dark brown
WPMDB10	32	male	Dark brown

Table 9 Summary of Exposure and Health Information

Sample ID	What were you doing when exposed to chemicals at ATS drug lab?	How were you exposed?	How long were you exposed?	Were you wearing any PPE?	What did you do when you realised you were exposed to chemicals?	What health effects did you experience?	If you got medical help, what did you get treated for and for how long?	If you did not get medical help, did you have any health concerns related to the exposure?
WPMB01	attending clan labs	inhalation	unknown times	at times	no knowingly exposed	none	NA	NA
WPMBL02	NA	NA	NA	NA	NA	NA	NA	NA
WPMGR03	investigating offences	inhalation	exposed to approx. 120 labs	yes	make scene safe then continued working in it	inhaled ammonia and other gases - low level	no medical help required	No
WPFBL04	NA	NA	NA	NA	NA	NA	NA	NA
WPMBL05	investigating offences	inhalation	1 second	protective clothing	removed self from area	none	NA	No
WPMBL06	executing search warrant and located a drug lab inside a premises	inhaled (strong smell of ammonia)	2 minutes	No	go outside for fresh air	none, was hard to breath whilst in contaminated premises	No	No
WPMLB07	investigating	inhalation	seconds	yes	moved away from the area	headaches	No	No
WPMBL08	attended 94 labs for processing	NA	NA	NA	NA	NA	NA	NA
WPMDB09	NA	NA	NA	yes	NA	no effects	NA	No
WPMDB10	investigator	unknown	NA	yes	NA	NA	NA	NA

NA: Not answered as not applicable or not experienced by participant

Table 10 presents a summary of the results of hair analysis. There were no detections of methamphetamine or amphetamine in any of the hair samples analysed. The only detections were for codeine in 6 of the participants which is commonly used/prescribed for pain relief. Levels of codeine in hair have been reported to be dose related, noting that the concentrations are also dependant on melanin levels (220). The concentrations reported in this study are consistent with the range reported from doses more consistent with therapeutic use (221, 222). The actual therapeutic dose of codeine taken by the participants is not known. Higher concentrations of codeine in hair has been reported from opiate abuse (223, 224).

Table 10 Summary of Results: Drugs in Hair Analysis

Sample Name	Length (cm)	Sample divided	Cut length (cm)	Weight analysed (mg)	Drugs found	Concentration (pg/mg)
WPMB01	4	yes	4	20.36	codeine	**8**
				Hair wash	negative	
WPMBL02	3	yes	3	19.35	codeine	**410**
				Hair wash	codeine	**8**
WPMGR03	1.5	yes	1.5	19.21	codeine	**9**
				Hair wash	negative	
WPFBL04	22	yes	3	21.26	negative	
				Hair wash	negative	
WPMBL05	1.5	yes	1.5	19.89	negative	
				Hair wash	negative	
WPMBL06	3	yes	3	21.54	negative	
				Hair wash	negative	
WPMLB07	2.5	yes	2.5	20.87	negative	
				Hair wash	negative	
WPMBL08	4	yes	4	20.24	codeine	**14**
				Hair wash	negative	
WPMDB09	3	yes	3	20.52	codeine	**20**
				Hair wash	negative	
WPMDB10	1.5	no	1.5	21.06	codeine	**30**
				Hair wash	negative	

7.5 Discussion

Officers involved in the detection and investigation of clandestine drug laboratories have policies and procedures in place to ensure officers are aware of the hazards and they wear appropriate levels of PPE. The responses provided from the questionnaires indicate that the officers involved in this study have a range of experience in assessing and investigating clandestine drug laboratories. For four of the officers, inhalation exposures (of gases) were reported to have occurred where no or inadequate PPE was worn. Where exposed the officers reported that they removed themselves quickly from the premises. The only health effects reported were difficulty in breathing while inside the premises and headaches. No health effects required medical treatment and none of the officers reported any concern in relation to their exposure. The health effects reported by Police is further discussed, with comparison to data collected from other individuals in **Section 9.4**.

The hair analysis undertaken confirmed that for the approximate 1 to 4 month period prior to the collection of hair samples none of the officers involved in the study showed evidence of systemic intake of methamphetamine during the conduct of their duties. This is a generalised time period as it takes approximately 2 weeks for the internal dose to be incorporated into the hair that is outside of the scalp. Hence the test will not reflect exposures that may have occurred in the 2 weeks prior to sampling. In addition it is assumed that hair grows at a rate of 1 cm per month.

The data supports that the current protocols and level of PPE used to prevent exposure by Police to methamphetamine contamination in clandestine drug laboratories is preventing intake/exposure via inhalation and/or dermal absorption.

8.0 OPPORTUNISTIC CASE STUDIES

8.1 Introduction

Information and data has become available for a number of case studies in Australia and New Zealand where individuals and families have been exposed to methamphetamine contamination in properties that have not been remediated, or remediated adequately. The methods used to manufacture methamphetamine in New Zealand are the same as commonly used in Australia. In addition the culture, regulatory environment, health system, urban/rural settings and housing types are sufficiently similar that data obtained from these properties and individuals is considered to sufficiently representative of issues relevant to exposures and health effects that may occur in Australia.

The case studies presented provide varying amounts of co-located data on environmental contamination levels, biological data associated with exposure and/or health effects/observations. No other data collected in this study enables exposure to be characterised for individuals based on a combination of environmental and biological data, and/or observed health effects. The availability and access to such co-located data is limited and can only be obtained from opportunistic case studies such as the ones presented in this section. As the case studies are opportunistic, the information and data obtained relate to varying time periods and exposure situations.

Ethics approval to conduct interviews, evaluate behavioural issues in children using BASC-2:PRS and obtain hair samples, where relevant, was obtained from the Southern Adelaide Clinical Human Research Ethics Committee (Application 477.11).

8.2 CS01 Purchase of Rural Property

8.2.1 Overview of Case Study

A family consisting of 2 adults and 3 children purchased and occupied a rural property in Victoria, Australia. Approximately 8 months after moving in the local Council contacted them to inform them the property has been used to manufacture methamphetamine. Subsequent testing identified methamphetamine levels in the home that were approximately 50 times higher than the health based guideline. The family was relocated after living in the home for 18 months, during which time the youngest child (aged 7 years at the time of testing) had been reported (by the mother) to have developed respiratory problems and noticeable behavioural changes.

The family is concerned about a number of issues that include the health of their children and whether the property will be properly remediated so that it is safe to re-occupy.

This case study is referenced as CS01.

Timeline of events:

May 2013: Victoria Police seized chemicals and manufacturing equipment from a shed on the property and notified the local Council of the seizure (Police report is not available). The owner of the property was arrested and charged by Victoria Police. The letter provided to Council by Victoria Police noted that equipment and chemicals were removed from the site (from the shed) and that residues and wastes may remain on the property. The Victoria Police letter notes that it is unknown if processes or storages of chemicals occurred inside the house. Council issued an Improvement Notice under the Public Health and Wellbeing Act 2008 to the owner on 23 May 2013 requiring assessment and remediation. The Notice was not acted upon and only followed up by Council on the 20 December 2013, where the letter from Council stated the property was unsuitable for occupancy until assessment and remediation had been completed. However prior to this follow-up letter the owner sold the property.

August 2013: As part of the sale of the property a standard check was conducted of the title, including certificates issued by Council under Section 32 of the *Sale of Land Act 1962* and Section 229 of the *Local Government Act 1989* did not indicate that an outstanding Improvement Notice remained on the property. More extensive checks of Council records by the bank (mortgagee) did not identify any issues with the property or the outstanding Improvement Notice.

October 2013: New owners of the property settled on the property and moved in. The property was described by the new owners as “messy”. A significant amount of time was spent removing dumped materials (timber, tyres etc.) from the yard, cleaning the shed (blowing out dirt and dust) and inside the home (sugar washing walls, cleaning and vacuuming).

May 2014: Council contacted the new owners, unaware the property had been sold (initially believing the family were new tenants). At a meeting with Council the new owners were informed of an alleged clandestine drug laboratory in the rear sheds prior to the purchase. They stated the police only seized chemicals and the laboratory was not in the home. Council indicated they would engage consultants (at Council’s cost) to test the shed but were sure they would not find anything as the chemicals seized by police were sealed in containers. The family was advised to avoid the shed (in particular keep the children out). A letter from Council stated that there was no active manufacture and all equipment was packed down and stored in boxed and all chemicals were in sealed containers. The Council letter also stated “*due to the limited nature of illegal activity at the property it seems unlikely that any health risks will arise from continuing use of the land*”.

Late May 2014: Preliminary testing (at Council’s expense) was undertaken in the shed and stables (attached to the shed) only.

June 2014: The owners were advised by Council that the preliminary testing identified contamination in the shed. Review of the testing report indicates that the preliminary testing

involved semi-quantitative immunoassay methods (as described in **Section 6.2**), with positive detections (above 0.5 μg/100 cm^2) at all locations sampled inside the shed. Council issued another letter indicating that the preliminary results showed evidence of some contamination in the shed and stables. The letter stated access to the main shed and stables is to be restricted, especially to children. The letter also states that "*there are no risks associated with ordinary access to, and use of, the remainder of the property*". It is noted at this time no testing was undertaken anywhere else on the property, only in the shed and stables. The family was advised in late June that additional testing would be required. The owners did not want testing in the house as they had already been told it was safe. But because they had young children they agreed to limited testing in the home.

October 2014: Additional testing was undertaken by the consultants engaged by the Council. This included 3 locations from the shed and 4 locations inside the home. The sampling involved wipe sampling and quantitative laboratory analysis (using GC/MS methods) of methamphetamine residues. This data showed elevated levels of methamphetamine residues in the shed and inside the home, approximately 50 to 130 times higher than the health based guideline for methamphetamine of 0.5 μg/100 cm^2. Analysis also reported detections of pseudoephedrine, amphetamine and ephedrine in all samples (indicative that manufacture had occurred in the shed and in the house). The report indicated that some contamination may be present due to use (smoking) of the manufactured drug (not known or confirmed). The owner's possessions located inside the shed had shown methamphetamine contamination and hence the owner's property throughout the shed and house was noted to require assessment for contamination. The consultant's report provided some recommendations for remediation (including removal and replacement of plasterboard, fans, electrical fittings etc.). No remediation action plan (providing detail of the remediation required) has been provided at the time of the case study.

March 2015: The family moved out of the home (at Council's expense), leaving furniture and personal possessions behind. No remediation works have started.

March 2015: A site visit by the researcher identified the presence of a septic system on the property, drinking water supply collected from the roof of the house (where indoor fans and vents discharge) and some areas of the yard (within easy walking distance from the house and shed) where there are hollows and no grass was growing (and has not grown for the 18 months the owners were living at the property). Inside the home is clean and well presented. The homeowner noted that when they first moved in, the filter of the air conditioner was stained yellow when removed for cleaning. The filter was washed out and replaced in the home.

The youngest child's room is located directly opposite the laundry and back door. High levels of methamphetamine residues were reported in the laundry and hall outside the room (a potential location of manufacture, with residues potentially blowing across the hall into the room). The children's bedrooms have not been tested.

The remediation of the property is complicated by the presence of the owner's property which has value (monetary and emotional) and requires testing, cleaning or disposal. The site is also a working farm with beef cattle present. The business is required to stop while the contamination assessment/remediation is undertaken. In addition there is a local reputation issue with produce from the property that needs to be addressed (i.e. perceived contamination of produce, noting it is a small country town where everyone knows about the contamination – the drug property). The owners are very concerned with the whole situation.

8.2.2 Data Collection Methods

Informed consent was obtained from the property owners to utilise information and data relevant to the contamination identified at the property. In addition informed consent was obtained from the owners/parents to collect additional information and collect hair samples from both parents and all three children.

The parents/owners were interviewed by the researcher to obtain information on the timeline of events and any other information they considered relevant to understanding their concerns.

In addition a questionnaire (included in **Appendix C**) was completed by the parents (for themselves as well as for their 3 children) in relation to their observations on exposure and health issues relevant to living at the property.

Environmental data provided in assessment reports prepared by Council in relation to characterising the level of methamphetamine contamination in the home and in the shed was obtained.

The mother completed Behaviour Assessment System for Children, Second Edition (BASC-2) (225) forms for each child. BASC-2 is a standardised assessment tool that provides information to assist in assessing a child's behavioural, emotional and adaptive functioning. It can be used with children aged from 2 years to adolescents aged to 21 years. There are a range of forms and scales available. For the purpose of this assessment the Parent Rating Scales (PRS) were used. The PRS forms used related to the ages of the children residing at the premises, i.e. aged between 6 and 11 years. The scales use four-choices for responses to each of the 160 questions asked: Never, Sometimes, Often and Almost Always.

Hair samples were collected from the parents and children for inclusion in this study. The hair samples were collected using the methodology outlined in **Section 7.2**.

8.2.3 Analytical Methods

Hair Samples

Hair samples were analysed by Forensic Science SA for methamphetamine and amphetamine in accordance with the methodology outlined in **Section 7.3**.

Behavioural Assessment

The behavioural assessments, BASC-2 assessments, were analysed by utilising the on-line clinical evaluation tool Q-global (226). The responses provided were entered into the online system, with the data entry validated prior to any assessment being undertaken. The scoring system used first checks that the responses provided are valid (i.e. the parent has not depicted a child's behaviour in an inordinately negative fashion or given inconsistent responses). The results can be normalised against two population groups:

1. General: A general population of 4800 American children and adolescents from various settings; and
2. Clinical: A clinical sample of 5281 American children and adolescents who were diagnosed with emotional, behavioural or physical problems.

As the children involved in this study are considered to be representative of the general population (i.e. not reported to have been formerly clinically diagnosed with emotional, behavioural or physical problems) the responses provided were normalised against the General population group, both separate gender and combined gender groups.

The PRS scoring system evaluates the following categories and sub-categories:

Category	Sub-category
Externalising problems	Hyperactivity
	Aggression
	Conduct problems
Internalising problems	Anxiety
	Depression
	Somatization
Behavioural Symptoms Index (includes externalising problems)	Atypicality
	Withdrawal
	Attention problems
Adaptive skills	Adaptability
	Social skills
	Leadership
	Activities of daily living
	Functional communication

In addition the scoring system provides the following assessment:

- Content Scales are secondary to the main categories and sub-categories and they evaluate anger control, bullying, developmental social disorders, emotional self-control, executive functioning, negative emotionality and resilience.
- A clinical summary is provided based on the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, Text Revision (DSM-IV-TR) Diagnostic Considerations (227). The manual is published by the American Psychiatric Association and includes every condition officially considered a mental illness by that organisation.

8.2.4 Results

Contamination Levels in the Home

The family had been living in the home for 18 months prior to moving out. Testing of methamphetamine residues by the Council was undertaken approximately 1 year after they had moved in and 18 months after Police had seized equipment and chemicals from the property. It is not known when, how much and for how long the manufacture of methamphetamine occurred. It is likely that residues inside the home were higher when the family first moved in. However there is no data for contamination levels in the home when the family moved in, or exposure levels that may have occurred during or after cleaning and use of the house and shed.

The consultants engaged by the Council undertook preliminary analysis of methamphetamine surface residues from 11 locations within 2 external sheds in May 2014. This testing confirmed the presence of residues at all 11 locations in excess of 0.5 µg/100 cm^2.

Further testing of surface residues in the external sheds and inside the residential home was undertaken by the consultants engaged by Council in November 2014. The testing was conducted by the consultants using surface swabs with analysis using GC/MS (using a method adapted from NIOSH Method 9106) by Forensic and Industrial Science Laboratory, an independent company located in Auckland, New Zealand.

Table 11 presents as summary of the residues reported as a result of the testing.

Table 11 Summary of Surface Residue Levels for CS01 (November 2014)

Location	Surface residues reported (µg/100 cm^2)			
	Methamphetamine	**Pseudoephedrine**	**Amphetamine**	**Ephedrine**
External Sheds				
South wall shed 2	35.9	0.86	present	present
North wall shed 2	64.7	2.01	present	present
West wall shed 3	0.59	ND	present	present
Inside Residential Home				
Laundry Wall	23.1	0.04	present	present
Kitchen/dining wall	13.7	Trace	present	present
Hallway wall (outside children's bedrooms)	26.0	Trace	present	present
Living room wall (outside master bedroom)	11.7	Trace	present	present

ND means not detected above the limit of detection of 0.03 µg/100 cm^2

Trace means detected and present at levels below 0.03 µg/100 cm^2 (instrument response is close to background response)

Present means detected at a level that is considered quantifiable (i.e. above a trace level) but has not been quantified using the analytical method

Health Information

Information was provided by the parents during the interview by the researcher and from the completion of the questionnaire. None of the participants had used amphetamine-type drugs in the past. In relation to health concerns **Table 12** provides a summary of the information obtained for each of the family members who resided at the property.

Blood Test Results:

All members of the family had their blood tested by the family doctor in February 2015. These test results have been provided by the family for consideration in this study. All the test results were normal. No drugs were detected in blood test above the reporting cut-off which was 300 µg/L for amphetamine type substances.

Table 12 CS01: Summary of Health Issues Reported by Participants

Participant	Health effect reported							Comments
	Persistent cough	Asthma	Skin problems	Watering eyes	Sore eyes	Trouble sleeping	Unusual behaviour	
Mother (aged 40 years), CSF40	Y			Y	Y			She noted that she regularly cleaned the house. She has also reported weight loss, a feeling of "running-on-empty" but still having energy, sciatica (both legs) and improved (long-distance) vision while living at the house. She is noted to be a smoker (only outside the home) and is currently healthy.
Father (aged 38 years), CSM38				Y	Y	Y		He noted that he has regularly cleaned out the shed using a blower. When blowing out the shed he has reported head spinning and blurry vision. Other health effects reported while living in the home include poor memory. He is noted to be a smoker (only outside the home) and is currently healthy.
Child (female aged 11 years), CSF11	Y			Y	Y	Y	Y	In relation to the health effects reported, she had trouble sleeping – particularly getting to sleep, and was noticeably more irritable than normal when living in the house. Her mother considered that she was currently healthy.
Child (male aged 8 years), MSM8		Y		Y	Y		Y	In relation to the health effects reported, he was noticeably more irritable than normal when living in the house. His mother considered that he was currently healthy.
Child (male aged 7 years), CSM7	Y	Y	Y	Y	Y	Y	Y	Has developed asthma symptoms and wheezing (not associated with cold/flu) since living at the house (as documented with school sick-bay records from current and former schools). A trial of asthma medications (venolin, atrovent and seritide) did not affect the asthma or wheeze symptoms. The General Practitioner (GP) indicated that the respiratory issues were not asthma. No asthma or wheeze was present (as confirmed from GP medical records) prior to moving into the home. These symptoms have continued after moving out of the house, but are very infrequent (much less frequent than when living in the home). These respiratory issues will be further monitored by a medical professional. The school has reported that since moving into the house has noted he is easily distracted, eyes seem glazed and he is tired. The current school has provided a letter outlining these health issues and observations. These behaviours were not identified at the previous school, when living at previous home, as indicated by school reports provided. He has reported trouble sleeping with heightened fear levels and vivid/scary dreams since being in the house. These issues have not occurred since moving out of the house, even when living in a new, unfamiliar house. Has had a persistent cough, watering eyes, sore eyes, skin problems (suffered from allergies/rashes prior to living at home), irritability and unusual behaviour (described as aloofness). His mother did not consider he was healthy at the time of this assessment.

Behavioural Assessment

The BASC-2 PRS forms were completed by the mother for all three children and the responses evaluated using the online scoring system Q-global. As there are only three children involved in this study no statistical analysis can be undertaken of the results obtained. However the clinical analysis of the responses, where these are compared with responses from a general population group, provide an indication of how the observed behaviour of the children compares with what is expected in a normal population of children.

Table 13 presents a summary of the results of the BASC-2 assessment for each of the children involved in the study. The assessment has been undertaken in March 2015 immediately after moving out of the home and in mid-July 2015, after being out of the home for approximately 4.5 months. It is noted that while the family had moved out of the home, they were placed in rental accommodation with no access to their personal possessions (all of which remain in the contaminated home).

The table presents a summary of the T-score and percentile for each category/sub-category and where this places the behaviour within the normal range for children of the same age, or if the score indicates the child may fall into one of the following areas:

- At-risk: may identify a significant problem that may not be severe enough to require formal treatment or may identify the potential of developing a problem that needs monitoring
- Clinically Significant: high level of maladjustment that usually requires follow-up

To assist with reviewing the results of the assessments **Figure 38**, **Figure 39** and **Figure 40** show the T-score profiles for each of the children for the testing conducted in March and July 2015.

For the youngest child, a number of sub-categories have been scored as at-risk or clinically significant in the test conducted in March 2015. These aspects relate to anxiety, attention issues and somatisation (where psychological distress is expressed as physical symptoms) which are consistent with the health problems/observations provided by the mother. It is noted that the child undertook a behavioural assessment (test method unknown) at Monash University prior to moving into the home. The earlier assessment did not identify any of the behavioural issues identified in the BASC-2 assessment conducted in March 2015. The only issue identified in the earlier test related to social skills.

The follow-up testing conducted in July 2015 identified the following:

- For the youngest child, the areas where the test scores were elevated in the March test remained elevated, however none were ranked as clinically significant. This indicates some improvement in somatisation since moving out of the home.

- The older male child (aged 9 years at the time of the second test) reported a change in scores particularly related to anxiety and somatisation to a level ranked as at-risk. The eldest child (female aged 11) reported a change in scores related to resiliency to a level ranked as at-risk. In addition a number of other scores have changed (but remain within the normal range). These changes may be associated with the presence of an environmental stressor as the family has lived in a rental property for more than 4 months without any of their own possessions. The assessment and remediation of their home is being delayed by the local Council and at the time of this research, no further testing or remediation work had commenced. Hence the current living situation for the family (and additional stressor) may continue for a long period of time.

All of the test-results have been provided to the family.

Table 13 CS01: Outcomes of Behavioural Assessment, BASC-2-PRS

Category/sub-category	Results for Each Child in Study: T-score [percentile] and whether normal for age					
	CSM7		CSM8		CSF11	
	March 2015	July 2015	March 2015	July 2015	March 2015	July 2015
Age (at time of test)	7	7	8	9	11	11
Gender	male	male	male	male	female	female
Test validity	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Externalising Problems						
Hyperactivity	54 [72] normal	47 [43] normal	42 [21] normal	45 [38] normal	40 [12] normal	39 [8] normal
Aggression	37 [5] passive	48 [48] normal	41 [16] normal	44 [31] normal	42 [24] normal	40 [9] normal
Conduct problems	49 [51] normal	59 [83] normal	45 [35] normal	46 [39] normal	46 [43] normal	43 [24] normal
Composite scale	46 [41] normal	52 [64] normal	42 [19] normal	44 [32] normal	42 [20] normal	40 [11] normal
Internalising problems						
Anxiety	**62 [87] at-risk**	**62 [89] at-risk**	58 [79] normal	**64 [91] at-risk**	58 [80] normal	57 [77] normal
Depression	51 [63] normal	49 [55] normal	41 [15] normal	49 [56] normal	47 [47] normal	51 [64] normal
Somatization	**73 [97] clinically significant**	**67 [94] at-risk**	59 [83] normal	**61 [86] at-risk**	58 [79] normal	53 [66] normal
Composite scale	**65 [90] at-risk**	**62 [88] at-risk**	53 [68] normal	**60 [85] at-risk**	55 [74] normal	55 [72] normal
Behavioural Symptoms Index						
Atypicality	57 [82] normal	57 [83] normal	43 [28] normal	44 [30] normal	44 [33] normal	44 [30] normal
Withdrawal	44 [33] normal	46 [41] normal	42 [25] normal	44 [34] normal	42 [21] normal	51 [63] normal
Attention problems	**62 [84] at-risk**	**62 [85] at-risk**	49 [49] normal	51 [56] normal	52 [62] normal	53 [64] normal
Composite scale	51 [61] normal	52 [65] normal	41 [17] normal	45 [35] normal	43 [26] normal	45 [36] normal
Adaptive Skills						
Adaptability	60 [84] normal	51 [51] normal	69 [98] normal	53 [58] normal	50 [45] normal	48 [41] normal
Social skills	65 [94] normal	46 [32] normal	69 [98] normal	59 [78] normal	55 [65] normal	54 [64] normal
Leadership	66 [95] normal	57 [73] normal	60 [84] normal	42 [23] normal	58 [79] normal	49 [44] normal
Activities of daily living	53 [61] normal	52 [54] normal	56 [72] normal	52 [55] normal	50 [49] normal	49 [45] normal
Functional communication	66 [99] normal	61 [88] normal	60 [82] normal	45 [29] normal	53 [56] normal	57 [73] normal
Composite scale	64 [93] normal	54 [63] normal	65 [94] normal	50 [49] normal	54 [63] normal	52 [55] normal
Content Scales						
Anger control	45 [39] normal	41 [17] normal	39 [10] slightly better	40 [12] normal	49 [54] normal	45 [36] normal
Bullying	38 [7] normal	39 [9] normal	38 [4] normal	46 [42] normal	44 [34] normal	46 [42] normal
Developmental social disorders	39 [11] slightly better	47 [42] normal	34 [2] slightly better	47 [43] normal	43 [27] normal	47 [43] normal
Emotional self-control	50 [58] normal	55 [74] normal	44 [32] normal	45 [36] normal	42 [23] normal	52 [65] normal
Executive functioning	49 [53] normal	48 [46] normal	39 [12] slightly better	45 [33] normal	48 [47] normal	47 [42] normal
Negative emotionality	52 [64] normal	57 [78] normal	39 [13] slightly better	43 [27] normal	47 [43] normal	47 [42] normal
Resilience	57 [71] normal	48 [39] normal	66 [97] normal	48 [40] normal	49 [43] normal	**39 [13] at-risk**

Category/sub-category	Results for Each Child in Study: T-score [percentile] and whether normal for age					
	CSM7		CSM8		CSF11	
	March 2015	July 2015	March 2015	July 2015	March 2015	July 2015
Clinical indexes						
ADHD probability	**52 [66] possible**	48 [48] normal	39 [12] normal	48 [47] normal	45 [37] normal	46 [39] normal
EBD probability	36 [6] normal	48 [47] normal	34 [3] normal	43 [25] normal	47 [45] normal	51 [57] normal
Functional impairment	43 [28] normal	48 [49] normal	41 [20] normal	50 [54] normal	47 [44] normal	50 [56] normal
Clinical summary	Clinically significant somatization and at risk anxiety and attention problems resulting in possibility of ADHD (inattentive type). Subject parents been advised of results for follow-up.	Elevated attention, anxiety and somatisation scales. No scales ranked as clinically significant.	No significant BASC-2 scores suggesting absence of clinical syndromes associated with the scales considered	Elevated anxiety and somatisation scales. Anxiety issues common in children.	No significant BASC-2 scores suggesting absence of clinical syndromes associated with the scales considered	Resilience identified in at-risk range. No other scores were significant.

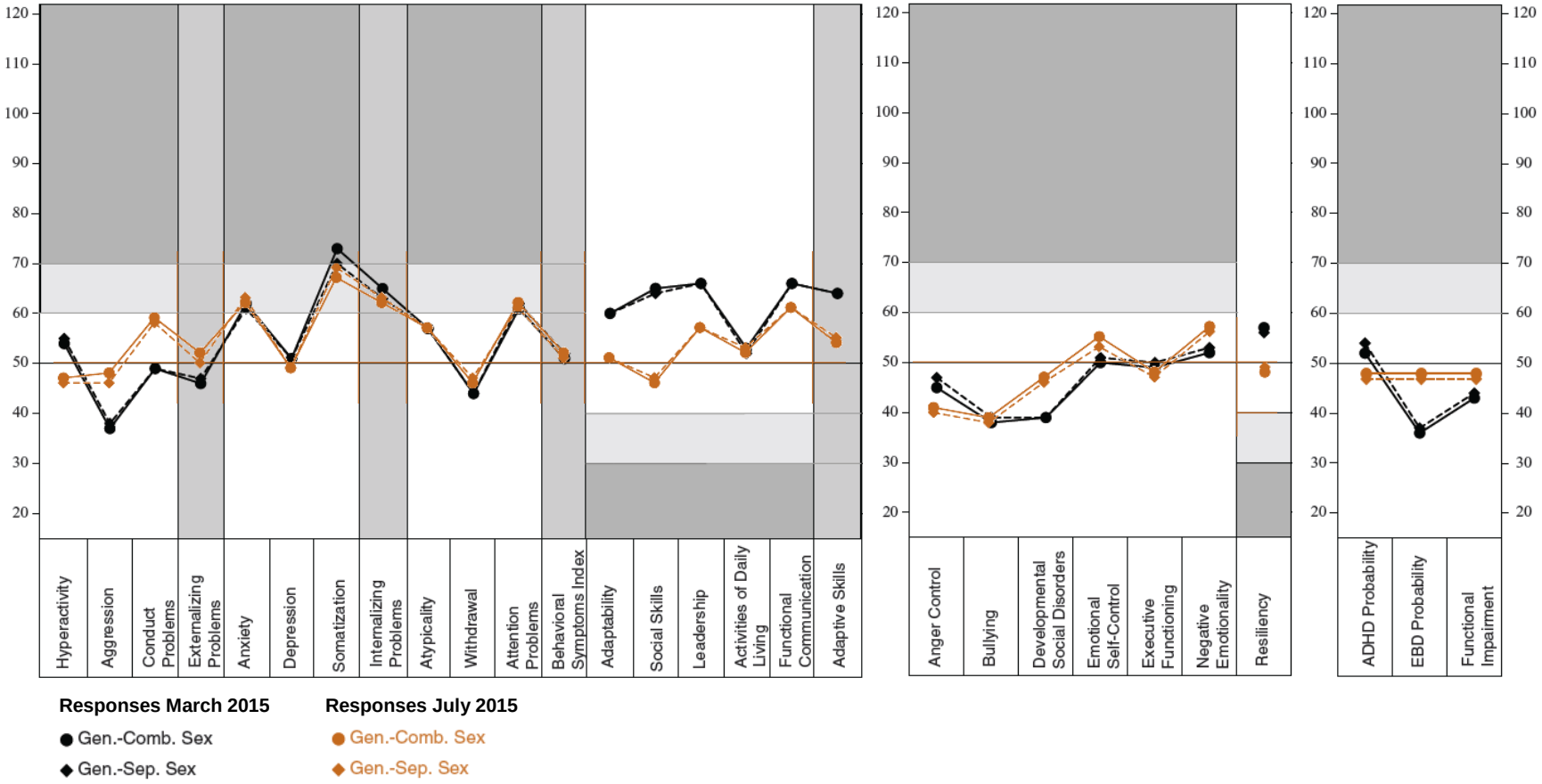


Figure 38 BASC2-PRS T-Score Profiles: CSM7 (Male Child Aged 7 Years)

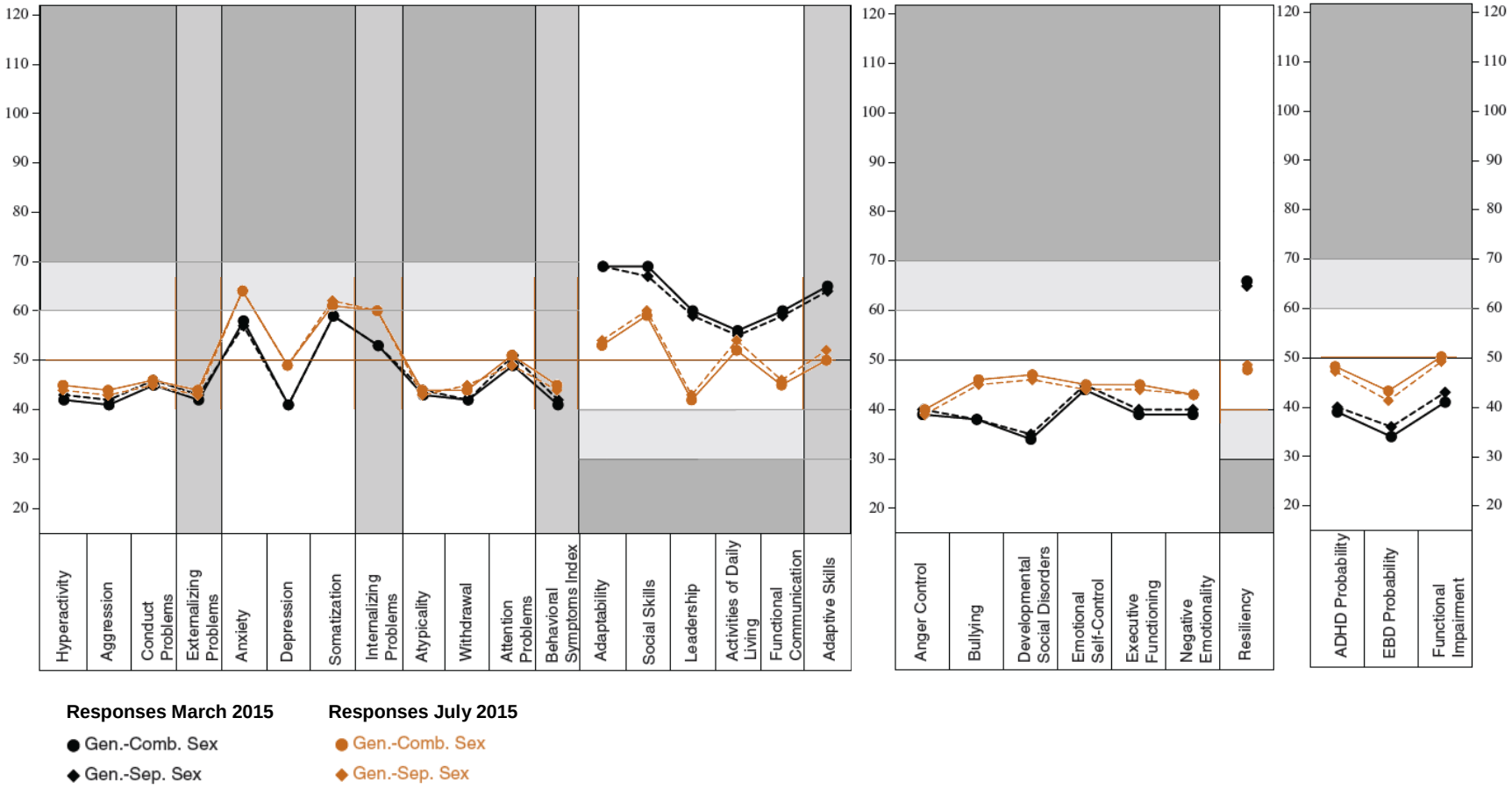


Figure 39 BASC2-PRS T-Score Profiles: CSM8 (Male Child Aged 8 Years)

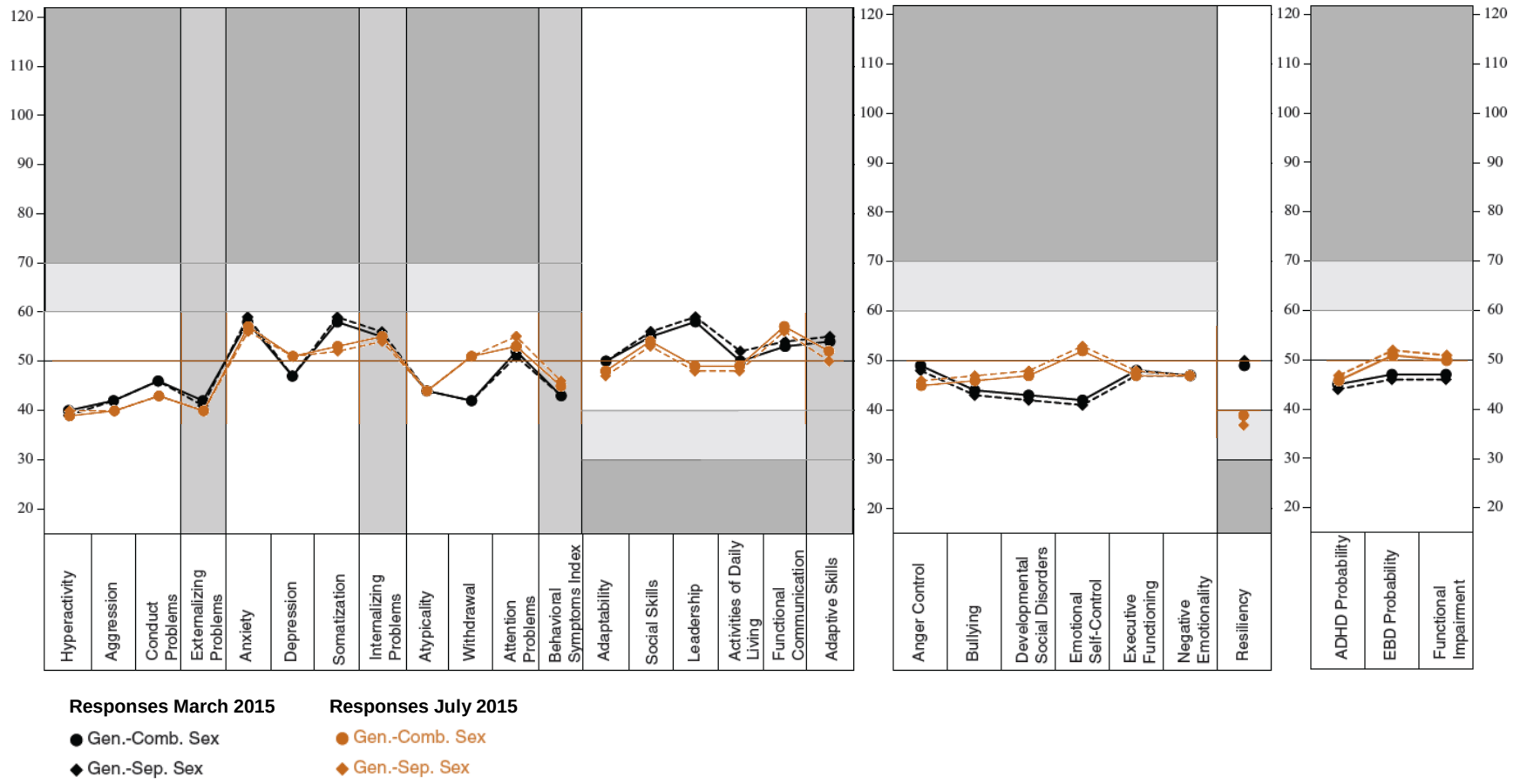


Figure 40 BASC2-PRS T-Score Profiles: CSF11 (Female Child Aged 11 Years)

Hair Analysis

Samples of hair were collected from all family members in March 2015 within 1 week of moving out of the home. In addition follow-up hair samples were collected from the 3 children at the end of June 2015, after they have been out of the home for 4 months.

Table 14 and **Table 15** present the results of hair analysis undertaken on these samples.

Table 14 CS01: Results of Drugs in Hair Analysis – March 2015

Sample ID	Age	Gender	Length (cm)	Sample divided	Cut length (cm)	Weight analysed (mg)	Drugs found	Concentration (pg/mg)
CSM7	7	Male	4	yes	4	20.89	methamphetamine	**460**
							amphetamine	**20**
						Hair wash	negative	
CSM8	8	Male	3	yes	3	21.48	methamphetamine	**330**
							amphetamine	**16**
						Hair wash	negative	
CSF11	11	Female	35	yes	4	19.27	methamphetamine	**50**
						Hair wash	negative	
CSF40*	40	Female	33	yes	5	19.74	methamphetamine	**17**
						Hair wash	methamphetamine	**8**
CSM38	38	Male	1	yes	1	19.78	(methamphetamine)	**5**
						Hair wash	negative	

* Hair noted to have been dyed

Table 15 CS01: Results of Drugs in Hair Analysis – June 2015

Sample ID	Age	Gender	Length (cm)	Sample divided	Cut length (cm)	Weight analysed (mg)	Drugs found	Concentration (pg/mg)
CSM7	7	Male	4.5	no	3	18.07	negative	
						Hair wash	negative	
CSM8	8	Male	2.5	no	2.5	18.77	methamphetamine	**60**
						Hair wash	negative	
CSF11	11	Female	42	no	3	17.54	negative	
						Hair wash	negative	

8.2.5 Discussion

The environmental samples from the home and hair analysis results indicate all members of the family have been exposed to methamphetamine in the past 3-4 months. Based on information provided the family has been exposed to methamphetamine contamination in the home for a period of approximately 18 months. The levels of exposure are likely to have been higher than reported in the data collected in this study as the concentration of methamphetamine residues inside the home are expected to have decreased over time.

Discussions with the family in relation to the hair results indicates that the levels reported in hair correlate well with information on the potential for exposure:

- The two younger children are boys, with the lowest body weights in the family, regularly played games and undertook activities that involved rolling on the floor, running around the home rubbing hands on walls, touching items and other parts of the house regularly and washed their hands less frequently than other family members.
- The older child is female spends more time on electronic media than being involved in the same active play as the younger brothers.
- The mother regularly cleans the home and has indicated that even after they had just moved out of the home (when the hair samples were collected) she still returned to the home to clean. The regular cleaning of the home is the likely cause of the external contamination on the hair. While she does undertake regular cleaning activities her weight is greater than the older child and her hair is dyed, which has been shown to damage the hair resulting in decreased levels of methamphetamine and amphetamine (228). One study has suggested that more than half the drug levels in hair may be lost after chemical treatment of the hair (229).
- The father works out of the home most of the day and his hair results show the lowest level of contamination.

One of the difficulties with hair analysis is the existence of a dose-hair relationship. The available studies indicate that while there is significant variability between individuals, within an individual there is a good correlation between dose and the concentration of methamphetamine, amphetamine as well as the sum of methamphetamine and amphetamine in hair (200, 205). On a qualitative level, the data reported for the family involved in this case study supports this outcome as higher levels of exposure (based on time in the contaminated home, body weight and behavioural considerations) are observed to be associated with higher levels of methamphetamine and amphetamine in hair.

Amphetamine is the major metabolite of methamphetamine and the detection of both methamphetamine and amphetamine is generally considered to be indicative of systemic

absorption of methamphetamine, however amphetamine is noted to also be present from the manufacture of methamphetamine in clandestine drug laboratories which can complicate interpretation of the data.

For the two younger children both the primary drug, methamphetamine, and the metabolite amphetamine was detected in the hair samples. The methamphetamine to amphetamine (MA:AMP) ratio was calculated to be 21 to 23. This ratio is consistent with the mean ratio of MA:AMP of 21 reported from hair samples collected from children removed from clandestine drug laboratories (208) and 26 from drug exposed children, from manufacture and use of methamphetamine (230). For drug users the MA:AMP ratio is typically around 10 (175), with a range reported from 3 to 50 (231). This ratio has been found to increase with the duration of drug abuse (193) and presumably environmental exposures. This has been observed in this case study with the MA:AMP ratio found to be at the upper end of the range reported for drug users.

The MA:AMP ratio from this case study could be used to estimate the level of amphetamine that may have been present in the hair of other family members. The estimated level of amphetamines in hair for these samples would be below the detection limit of the analysis method.

To provide some context in relation to the levels of methamphetamine reported in the hair of the family in this case study, the levels reported have been reviewed against published studies on measured levels of methamphetamine in hair from different types of exposure. There are a number of published studies that provide analysis of methamphetamine in the hair of known or suspected drug users, however many of these studies utilise high cut-off levels in reporting the hair data to specifically exclude other low level exposures, from amphetamine based medications or other environmental exposures. Where the reporting cut-off is elevated above the methamphetamine levels reported in this case study, the data is not considered to be suitable for the purpose of comparison. For the purpose of comparison, the following data is considered relevant:

- Analysis of hair from 52 children aged 2 months to 15 years removed from clandestine drug laboratories in New Zealand between 2008 and 2010 (208) reported a 73% detection of methamphetamine above the limit of reporting (LOR) of 0.1 ng/mg. The level of methamphetamine reported in the hair samples ranged from 0.1 to 131 ng/mg, with the highest levels reported in children aged under 5 years. This study also reported levels of methamphetamine detected in adult users in New Zealand (from 90 samples analysed by the same laboratory) ranged from 0.1 to 92 ng/mg.
- Analysis of hair from 91 children environmentally exposed to methamphetamine (from drug use or manufacture in the home) aged 1 month to 17 years in California (230) reported 75.3% detection of methamphetamine above the LOR of 0.1 ng/mg. The level of methamphetamine reported in the hair samples ranged from 0.1 to 16.8 ng/mg, with the highest levels reported in children aged under 5 years.

- Analysis of drugs in hair undertaken as part of workplace screening of drug users in the United Kingdom from 2001 to 2005 on 34,626 samples reported methamphetamine levels that ranges from the LOR of 0.1 ng/mg to 128.1 ng/mg (229).
- Analysis of methamphetamine in hair from 9 long-term adult drug users in California, where the dose ranged from 0.25 to 4 g/day (common doses for methamphetamine smoking), reported levels (in different hair segments) that ranged from 0.38 to 35.23 ng/mg (205). The study indicated that a dose of approximately 0.5 to 1 g/day of methamphetamine via smoking was required to produce detectable amounts of methamphetamine (>0.1 ng/mg) and AMP (>0.125 ng/mg) in hair.

Figure 41 presents a summary of the range of methamphetamine reported in the above studies, along with the levels reported in each of the family members included in this case study for comparison.

The methamphetamine levels reported in the hair for the family in March 2015 indicate that for the two younger children the levels reported (0.33 ng/mg and 0.46 ng/mg) are similar to the lower end of the range reported in children removed from clandestine drug laboratories and chronic adult drug users. In addition, the levels of methamphetamine detected are consistent with those expected from low level methamphetamine smoking of doses of approximately 0.5 to 1 g/day (205).

Further evaluation and discussion on the relationship between the reported levels of methamphetamine and amphetamine in the hair samples from the two younger children and potential exposures/intakes, based on consideration of dose-exposure/intake data-response data from methamphetamine smoking is presented in **Section 9.5**.

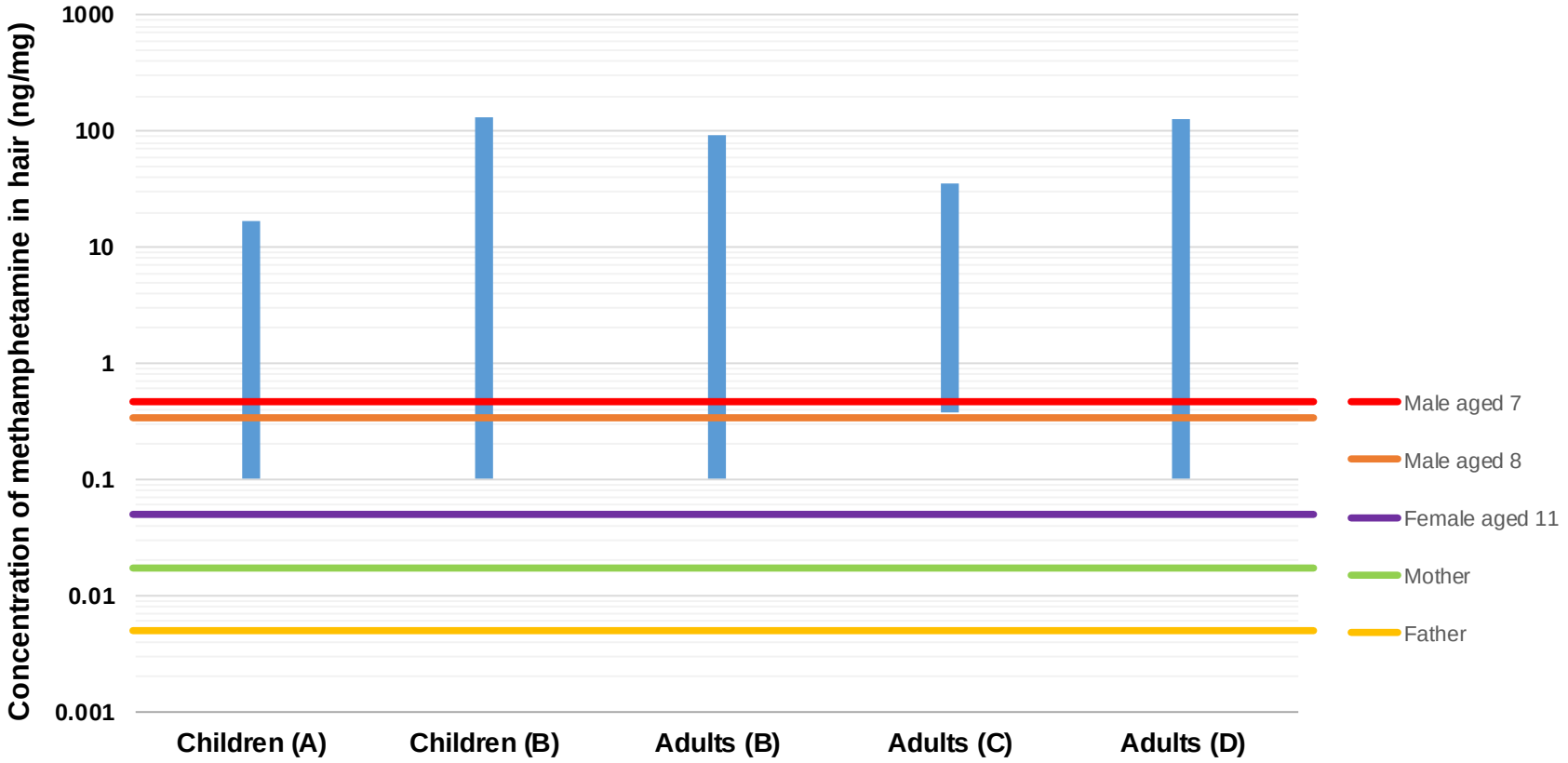


Figure 41 **CS01: Comparison of Methamphetamine Levels in Hair with Published Levels from Other Exposures**

[A – drug exposed children (methamphetamine drug laboratories and homes with users) from California (230); B – drug exposed children from clandestine drug laboratories and adult drug users in New Zealand (208); C – range reported in long-term adult drug users (based on doses of 0.25 to 4 g/day of methamphetamine) (205); D – range reported in adult workplace drug use testing (229)]. It is noted that for the published studies included in this figure the reporting limit for methamphetamine in hair was 0.1 ng/mg.

Once the family had moved out of the home exposure to methamphetamine stopped. Sampling collected in June 2015 showed that for two of the children (CSM7 and CSF11) the levels of methamphetamine and amphetamine had reduced such that they were no longer detectable in hair. A lower level detection of methamphetamine was reported in the hair of the middle child (CSM8). This result may be due to individual differences in hair growth rates such that the segment analysed from CSM8 also included some hair that reflected exposure in the home. The influence of individual variability of hair growth rates has been identified in other studies as an issue that potentially affects the interpretation of hair data (200, 205). The level detected in hair in June 2015 (60 pg/mg) was lower than reported in March 2015 (330 pg/mg).

Methamphetamine and amphetamine are rapidly removed/excreted from the body following exposure. In general, approximately 70% of a methamphetamine dose is excreted in the urine within 24 hours (178) regardless of the route of intake/exposure, however the time for elimination has been found to be longer with long-term users and individuals with alkaline urine (175). Where these factors are considered the elimination half-lives has been found to vary from 6 to 25 hours (175). These data support that following removal from exposure in the contaminated home it is expected that methamphetamine and amphetamine will be rapidly eliminated from the body, resulting in no further incorporation of these drugs into the hair.

Council issues

In Victoria, a Practice Note on Clandestine Laboratory Remediation, released in 2012 (17), provides guidance to Councils in relation to the remediation of former clandestine drug laboratories. The guideline outlines that once notified by Police of the presence of a former clandestine drug laboratory, the Council Environmental Health Officer (EHO) is required to notify the owner that assessment of contamination is required. The Victorian guidance makes it clear that it is the property owner's responsibility to engage the assessor and ensure the property is assessed and remediated, and be responsible for costs. Standard notification from Police typically provides information on the location of the property, states that hazardous chemicals and/or equipment suspected for use in the manufacture of illicit drugs were present and/or removed, residues of hazardous substances and waste produced may still remain on the property, indicates that the notification is issued in the interest of public health and safety and that the property may require assessment for future habitation. The notification also provides contact details.

In Victoria, residual contamination from the operation of a clandestine drug lab is acknowledged to be a serious health risk and as such is determined to be a "nuisance" under the *Public Health & Wellbeing Act 2008* (PHWA) (232). It is an offence under the act to cause a nuisance or knowingly allow a nuisance to exist on, or emanated from land. Hence land owners are required to abate the nuisance. Under the act, local Councils must investigate any notification of nuisance and have a duty to remedy the nuisance as far as reasonably possible. If the landowner does not remediate

the issue the Council may issue a Prohibition or Improvement Notice. The PHWA provides Authorised Officers the power to enter a premises, as well as “seal” the premises (to prevent habitation) until it has been assessed as safe for its intended use.

Where the property owner does not comply with the notice, Council may make a complaint to the Magistrates Court (under Section 197 of the PHWA), where an order may be made to the property owner to remediate the property. Council then also has the power to enter the property and undertake the remediation, and recover costs and expenses from the owner (or person on whom the order is made).

Where an owner cannot be identified or located Council may undertake steps to assess and remediate the property and recover costs from the owner at a later date if identified.

Under Section 63 of the PHWA, failure of Council to investigate a nuisance may result in a complaint to the Magistrates Court who may require Council to pay costs and expenses incurred.

In this case study, the Council issued an Improvement Notice under the PHWA to the former owner within 10 days of receiving notification from Police. The Council sent a follow-up letters to the owner after 3 months and again after 7 months. Council did not enforce the Improvement Notice or take court action to obtain an Order on the property owner. In addition no steps were made to seal the premises to prevent habitation. During this period of time the property was sold. All searches undertaken as part of the property sale (including searches conducted by the mortgagee) with the Council did not identify that an Improvement Notice under the PHWA had been issued and not complied with, nor were there any indications provided that the property is not habitable until the Improvement Notice is complied with.

Once the property had been sold it took Council a significant period of time, approximately 7 months, to contact the new owner. Once contact was made the Council did not provide all information which was available to Council that would have enabled the owners to have fully understood the health risks that may have been posed by the property, or take early actions to remove their family from the home until the home had been fully assessed and remediated. As a result the family spent a long period of time living in the contaminated home before testing was undertaken to show that the property was contaminated and not habitable. Information from this case study provides evidence that the family was exposed to significant levels of methamphetamine while living in the home, resulting in respiratory and behavioural effects in the youngest child.

While the Victorian Practice Note (17) recognises that former clandestine drug laboratories pose a serious health risk, it is important that Councils fully understand the level of risk posed by these properties to the health of occupants. It is important that timely steps are taken to enforce powers

present under the PHWA and that changes are made to ensure that any Improvement Notices issued under the PHWA that deem a property uninhabitable are included with property title information so any prospective purchaser can be informed of the status of the property. In this case study significant costs are now expected to be associated with the assessment and remediation of the property and the owner's possessions. These costs (and other issues) are resulting in significant delays (over many months) for the further assessment and remediation of the property, with the owners expected to live in rented accommodation with no access to possessions.

8.3 CS02 Rental of Home Formerly used to Manufacture Methamphetamine

8.3.1 Background

A mother and 2 children (aged 12 and 17 years at the time of this study) rented a property in an urban area in early 2015 through a letting agent. At the time when signing the rental agreement there was no information provided that the owner of the property had been arrested for the manufacture of methamphetamine. Management of the property was undertaken by the owner's mother. At the time of rental, the owner's mother, sister and letting agent (a friend of the sister) were aware that the property had formerly been used to manufacture methamphetamine but the tenant was not informed.

It is understood that police had not advised the local Council of the property and Council had not issued any notices to the owner in relation to assessment and remediation.

The property was a single house property with most living areas located on the ground floor, however there was a granny flat (bedroom, kitchenette) located under the house (basement) along with access under the house (sub-floor area) and garage. When moving into the property the tenant noted that the house had been repainted, new carpets were present and there were new curtains. The teenage son lived in the granny flat, spending almost 24 hours per day in the room(s). During the time living at the property the mother reported unusual behaviour from the son who spent long periods of time in the granny flat for 4 weeks following moving into the house, followed by 6 weeks at a camp (i.e. out of the house) and then returning to live back at the house. The son was not known to have used any recreational drugs.

The tenant became aware that the property was formerly used to manufacture methamphetamine when "chatting" with a neighbour. The neighbour mentioned that the owner had been arrested and was in prison. The owner looked up the owners details in court records and discovered he was in prison for over 9 years for the manufacture of methamphetamine.

Concerned about whether there was a problem with the house, the tenant asked the property manager, the owner's mother, to get the property tested. This did not occur.

The tenant, concerned about the contamination status of the property and potential health issues with her family, organised the testing of surfaces inside the home. The testing identified the presence of methamphetamine residues. Once this was known advice was provided to move out of the property, taking no possessions. Council was notified and a notice (to clean up the property) has been subsequently issued to the owner.

8.3.2 Data Collection Methods

The tenant provided informed consent to provide access to data collected for the assessment of contamination in the property. In addition the tenant provided informed consent to provide information on the health of her and her children via interview and completion of a questionnaire.

In addition a behavioural assessment, using BASC-2 PRS forms for children aged 12-21 years was completed by the mother (refer to **Section 8.2.3** for details on the BASC-2 assessment). The behavioural assessment form was completed once for the daughter and twice for the son (once documenting his behaviour while living in the granny flat and again 4 weeks after moving out of the home).

Results for this case study have been identified using the prefix CS02.

8.3.3 Results

Environmental sampling

The home was rented unfurnished. Hence all property in the home was owned by the tenant and was present in the premises during the tenancy.

Preliminary testing was undertaken within the property on 16 April 2015. The preliminary testing involved the collection of 2 composite wipe samples and testing for the presence of methamphetamine (as a total mass) by Hill Laboratories (in New Zealand) using a modified NIOSH9111 method (LC-MS/MS analysis). The preliminary testing reported the following:

- Sample A – composite sample from kitchen, lounge, bathroom, bedroom 1, ensuite, bedroom 2, bedroom 3 and stairwell reported a mass of methamphetamine of 2.9 µg
- Sample B – composite sample from bedroom 4, living, kitchenette, bathroom, garage side room, garage and laundry (all on the lower level of home) reported a mass of methamphetamine of 12.6 µg

Amphetamine, pseudoephedrine and ephedrine were also detected in both of the composite samples. The preliminary sampling provided an indication of the presence of methamphetamine contamination.

A more detailed assessment of the contamination levels at the property was undertaken by consultants in May 2015. The detailed assessment reported the following:

- Testing for volatile organic compounds in air did not identify levels that were different from background, or levels that exceeded relevant health based guidelines
- pH levels were generally between 6 and 8, however the ensuite vanity reported a level of 9 and the kitchen range hood reported a level of 5
- Surface residue testing involved the collection of wipe samples as composites over a combined area of 100 cm^2 and analysis by Hill Laboratories using a modified NIOSH9111 method (LCMSMS analysis)
- Surface residue testing detected methamphetamine (0.02 to 1.6 µg/100 cm^2) and low level detections of amphetamine (0.02 to 0.05 µg/100 cm^2) on surfaces in the home, as summarised in **Table 16**. Testing of surfaces around door frames and windows that had not been repainted reported a level of 42 µg/100 cm^2. In addition, testing (through wipe sampling only) of mattresses soft furnishings and other possessions in the home reported detectable levels of methamphetamine (0.02 to 0.16 µg) on some surfaces. These results are summarised in **Table 17**.

It is noted that a ducted air conditioning system was present at the property. It has never been cleaned or tested.

Table 16 CS02: Summary of Surface Residue Levels Reported in Home

Sample Location	Results of analysis – average from all areas sampled (µg/100 cm^2)			
	AMP	MA	PSE	EPH
Upstairs				
Kitchen (bench, range hood, floor and window sill)	0.02	0.78	0.0075	0.005
Dining (floor and walls)	<0.01	0.06	<0.01	<0.01
Lounge (front door and walls)	<0.01	0.52	<0.01	<0.01
Hallway/stairs (walls)	<0.01	0.025	<0.01	<0.01
Bedroom 1 (window sill and walls)	<0.01	0.08	<0.01	<0.01
Bedroom 2 (window sill and walls)	<0.01	0.24	<0.01	<0.01
Bedroom 3 (floor and walls)	<0.01	0.14	<0.01	<0.01
Bathroom (toilet seat, bath and vanity)	<0.007	0.02	<0.007	<0.007
Ensuite (walls, floor and toilet seat)	<0.007	0.07	<0.007	<0.007
Downstairs				
Laundry (walls, floor, sink and cupboards)	0.005	0.07	<0.005	<0.005
Garage (tilter door and walls)	0.02	0.69	0.06	<0.01
Under house (upright post and shelf)	0.05	1.6	0.095	<0.01
Kitchenette (bench, floor and cupboards)	<0.007	0.04	<0.007	<0.007
Living area (heater and walls)	<0.01	0.22	<0.01	<0.01
Bedroom 4 (door and window sill)	0.02	0.56	<0.01	<0.01
Bathroom (toilet seat, floor and vanity)	<0.007	0.04	<0.007	<0.007
Doorframe, tops of doors and windows that have not been repainted	1.18	42	0.77	0.23

AMP = amphetamine
MA = methamphetamine
PSE = pseudoephedrine
EPH = ephedrine

Table 17 CS02: Summary of Residues Reported on Possessions in Home (wipe sampling)

Sample Location	Results of analysis (µg)	
	AMP	MA
Upstairs		
Dining table and chair	<0.02	0.10
Lounge sofa and chairs	<0.02	<0.02
Bedroom 1 desk and keyboard	<0.02	<0.02
Bedroom 2 headboard, mattress and table	<0.02	<0.02
Bedroom 3 chest of draws, bedframe and mattress	<0.02	0.02
Downstairs		
Bedroom 4 mattress and base	<0.02	<0.02
Living room sofa, cabinet and shelves	<0.02	0.16
Garage mattress	<0.02	0.02

AMP = amphetamine
MA = methamphetamine

Health information

The health issues reported by the participants, while living in the methamphetamine affected property, are summarised in **Table 18**.

Table 18 CS02: Summary of Health Issues Reported by Participants

Participant	Health effect reported							Comments
	Persistent cough	Asthma	Skin problems	Watering eyes	Sore eyes	Trouble sleeping	Unusual behaviour	
Mother (aged 44 years)			Y					No other health issues reported. She is currently healthy.
Child (female aged 13 years)						Y		She is currently healthy
Child (male aged 18 years)			Y			Y	Y	He lived in the basement level bedroom area, where he spent long periods of time, almost 24 hours per day. His behaviour was observed to be unusual, reported as irritable, depressed, moody, aggressive, non-compliant behaviour and lethargic. The behavioural issues did not continue after moving out of the home, with the observed behaviours reported to change after a week or two once out of the home. No documented evidence was available in relation to behaviours prior to living in the home.

It was also noted that a kitten brought into the home, where it lived in the basement area and had access to the sub-floor area, became sick. Once the property was known to be contaminated the kitten was moved to a new home where its health improved, back to normal, within a few weeks.

Behavioural assessment

The BASC-2 PRS forms were completed by the mother for both children and the responses evaluated using the online scoring system Q-global. Clinical analysis of the responses was undertaken with comparison against responses from a general population group to provide an indication of how the observed behaviour of the children compares with what is expected in a normal population of children.

Table 19 presents a summary of the results of the BASC-2 assessment for each of the children involved in the study. The assessment has been undertaken in June 2015 in relation to the observed behaviour of the children while living in the contaminated home.

The table presents a summary of the T-score and percentile for each category/sub-category and where this places the behaviour within the normal range for children of the same age, or if the score indicates the child may fall into one of the following areas:

- At-risk: may identify a significant problem that may not be severe enough to require formal treatment or may identify the potential of developing an problem that needs monitoring
- Clinically Significant: high level of maladjustment that usually requires follow-up

It is noted that since the family was renting the contaminated home, when they left the premises no further rent was paid and at the time of this research, they are still resolving the rent/cost issues with the landlord through the regulatory process. While this process is occurring a *black mark* remains against the tenants in relation to their rental history. Hence they cannot rent another home until this is resolved. As a result the mother and youngest daughter have lived in multiple properties including hotels and friends' homes. This situation may also be contributing to the observed behaviour in the children.

For the youngest child, a number of sub-categories have been scored as at-risk or clinically significant. These aspects relate to hyperactivity, anxiety and attention issues.

For the oldest child, many of the sub-categories have been scored as clinically significant. These include hyperactivity, aggression and conduct problems, depression and withdrawal, adaptive skills and content scales, many of which require follow-up. A number of the behavioural issues identified are consistent with those observed by the mother while he was living in the home. His behaviour was described as irritable, depressed, moody, aggressive, non-compliant and lethargic. While many of these behaviours were acknowledged by the mother to be common in teenage boys, the mother indicated that these behaviours were more pronounced and different while living in the property.

The results of the behavioural assessment have been provided to the mother with recommendations for follow-up assessments. It is noted that the behaviours reported in the assessments completed were observed during the time when living in the contaminated property. The mother has indicated that most of the observed behaviours have not continued since moving out of the home.

Table 19 CS02: Outcomes of Behavioural Assessment, BASC-2-PRS

Category/sub-category	Results for Each Child in Study: T-score [percentile] and whether normal for age	
	CS02F13	**CS02M18**
	June 2015	**June 2015**
Age	13	18
Gender	female	male
Test validity	Acceptable	Acceptable
Externalising Problems		
Hyperactivity	64 [90] at-risk	70 [95] clinically significant
Aggression	45 [35] normal	91 [99] clinically significant
Conduct problems	41 [16] normal	73 [96] clinically significant
Composite scale	50 [59] normal	81 [99] clinically significant
Internalising problems		
Anxiety	76 [99] clinically significant	58 [80] normal
Depression	58 [82] normal	78 [98] clinically significant
Somatization	44 [30] normal	63 [89] at-risk
Composite scale	61 [88] at-risk	70 [96] clinically significant
Behavioural Symptoms Index		
Atypicality	60 [86] at-risk	59 [85] normal
Withdrawal	54 [72] normal	89 [99] clinically significant
Attention problems	60 [83] at-risk	67 [93] at-risk
Composite scale	59 [83] normal	84 [99] clinically significant
Adaptive Skills		
Adaptability	48 [40] normal	31 [3] at-risk
Social skills	54 [62] normal	21 [1] clinically significant
Leadership	48 [43] normal	30 [2] clinically significant
Activities of daily living	47 [37] normal	17 [1] clinically significant
Functional communication	37 [11] at-risk	29 [3] clinically significant
Composite scale	46 [34] normal	21 [1] clinically significant
Content Scales		
Anger control	53 [68] normal	77 [98] clinically significant
Bullying	42 [22] normal	89 [99] clinically significant
Developmental social disorders	53 [64] normal	82 [99] clinically significant
Emotional self-control	49 [54] normal	79 [99] clinically significant
Executive functioning	52 [65] normal	73 [97] clinically significant
Negative emotionality	47 [42] normal	78 [99] clinically significant
Resilience	44 [26] normal	22 [1] clinically significant
Clinical indexes		
ADHD probability	58 [80] elevated	78 [99] potential
EBD probability	51 [55] normal	72 [98] potential
Functional impairment	56 [75] normal	83 [99] potential
Clinical summary	Clinically significant anxiety scale. Anxiety disorders are common in childhood but may also co-occur with other disorders. The elevated ADHD scales in conjunction with anxiety indicate potential for behavioural difficulties including problems with inattention and restlessness.	Clinically significant hyperactivity, aggression and conduct problems scales. The child may exhibit hyperactivity, verbal and physical aggression and socially deviant behaviours such as stealing, delinquency and property destruction. Elevated scales for depression and somatisation indicate elevated levels of internal distress and may exhibit irritable mood and oppositionality. The assessment indicates comorbid mood and behaviour problems that require follow-up.

8.3.4 Discussion

This case study highlights issues related to renting. As the property was not reported by Police as a former methamphetamine drug laboratory, the local Council was unaware that the property may have been contaminated. In addition the landlord of the property was the owner's mother. The owner was in prison for the manufacture of methamphetamine at another property. While the landlord cleaned the property, potentially to hide former methamphetamine manufacturing activities, no proper testing or professional cleaning to remediate the property was undertaken. The tenant was never informed that the home may have been used for the manufacture of methamphetamine, and there is no procedure in place to notify prospective tenants whether a property has a former history of manufacture.

Once renting a property the tenant is reliant on the honesty of the landlord to disclose information. This is less likely to occur where the landlord is related to the former owner (who caused the contamination) and where there are costs associated with undertaking a proper assessment and remediation.

In this case study the cleaning and replacement of curtains did not remediate the home. Methamphetamine contamination remained in the home and had resulted in contamination of the tenants' possessions. The contamination levels were lower (by around 100 fold) in areas that had been cleaned and repainted compared with the sample collected from uncleaned/unpainted surfaces. The air conditioning system was never cleaned nor tested in the home and is likely to be a source of elevated methamphetamine contamination in the home.

In relation to health effects, the most significant health effects reported were significant changes in behaviour reported in the older child (aged 18 years). He spent almost 24 hours per day, every day in his room located in the basement area which is noted by the mother to be common behaviour with teenage males who spend long periods of time playing computer games. The behavioural changes reported by the mother (as documented in the BASC-2-PRS assessment) included clinically significant hyperactivity, aggression and conduct problems, depression and withdrawal, adaptive skills and content scales. These behaviours were expressed as irritable, depressed, moody, aggressive, non-compliant and lethargic. The degree of change in behaviour cannot be determined as no information or assessment was provided for behaviours prior to living in the home. The mother indicated that these behaviours did not continue after moving out of the home. It was the observation of the child's significant behavioural changes between first moving into the home, spending time out of the home (while on camp for 6 weeks) and then moving back into the home, that raised concerns about contamination once she found out from a neighbour that the owner was in prison for the manufacture of methamphetamine.

Some behavioural issues were also identified in the behavioural assessment conducted by the mother for the younger child. These behavioural issues are much less significant than reported for

the older child. The behaviours of the younger child may also be affected by the ongoing instability in living arrangements since moving out of the home.

8.4 CS03 Purchase and Renovation of Home Formerly used to Manufacture Methamphetamine

8.4.1 Background

A home was purchased in June 2008 by a single female. The home was not known to have been formerly used for the manufacture of methamphetamine at the time of purchase as there was no notification on any searches undertaken during the sale of the property. Previous medical issues included some depression and anxiety and a prolapsed intervertebral disk in her neck, however the owner has indicated that she was in good health at the time the property was purchased. Upon purchase of the property the owner started renovations (prior to fully moving in). Within days of spending time in the home undertaking renovations (including sleeping overnight) the owner reported health problems that included eye irritation/infections, ear infections, skin rashes/sores and respiratory problems. The owner continued with work on the property as she remained unaware of the presence of contamination.

In September 2008 the owner noticed an article in the newspaper about a methamphetamine laboratory being seized by police in another suburb. The article showed the drug cook's dog which the owner recognised as the dog of the former owner of her home. The name of the former owner was also confirmed as the drug cook arrested. The owner notified police who later confirmed that a search warrant had been served on the former owner while he owned her property in 2007. The warrant found glassware used for manufacture of methamphetamine but there was insufficient evidence to arrest the owner for manufacture. The former owner was known to police for the manufacture of methamphetamine. The owner also notified the Council and was informed that Council was aware the home was formerly used to manufacture methamphetamine (from information provided by police in 2007), but that based on the police report the property was not classed as contaminated. It is noted that information provided by police to Council relates to the nature of the laboratory seized (active lab, inactive lab, equipment and chemicals stored) and does not relate to the remaining contamination levels nor the level of risk. The owner relied on this information and continued renovations.

The health problems experienced by the owner continued, and in October of 2008 she had the property tested. The testing identified the property was contaminated. She moved out of the home until December 2008 while it was cleaned/remediated. When she moved back into the home in December 2008 she continued to complete the last of the renovations required on the home. Once these works started she became unwell again.

As her health problems continued the owner had the property re-tested in August 2009. This testing identified that the property remained contaminated at lower levels than prior to the earlier remediation. The owner moved out of the home for another 2 months while the property was remediated again. Following completion of this round of remediation her health improved, although it is noted that she has developed some longer-term health problems as a result of the situation.

She subsequently sold the home and is now living elsewhere. The situation was complicated by the fact that she was employed by the local Council, also the subject of a compensation claim in relation to the purchase of the contaminated property.

8.4.2 Data Collection Methods

The property owner provided informed consent to provide access to data collected for the assessment of contamination in the property. In addition the owner provided informed consent to provide information on her health via interview and completion of a questionnaire.

Results for this case study have been identified using the prefix CS03.

8.4.3 Results

Environmental contamination

Testing of the home was first undertaken by consultants in October 2008. This testing reported the following:

- Elevated (above background) levels of VOCs in the home were detected using a photoionisation detector, particularly down the laundry sink, kitchen sink, bathroom sink and bathroom spa drains (120 ppb to 520 ppb above background). The levels were reported by the consultants to be indicative of the disposal of waste. The VOCs reported were stated (by the test consultants) to be primarily toluene.
- Acetone was reported in VOCs tested from the bathroom spa bath drain.
- Surface residue testing (immuno-assay type testing with a detection level of 10 µg) reported positive detections of methamphetamine in the kitchen and laundry window. The area over which these samples were collected is not known.
- Staining (potentially associated with reaction mixture spillage) was reported on surfaces near the bathroom spa bath.
- No areas of outdoor contamination or evidence of dumping of solvents were observed.

Further testing undertaken in August 2009, after remediation was undertaken (which involved a number of rounds of cleaning) identified that methamphetamine residues remained on surfaces (between 0.01 and 2 µg/100 cm^2) in the laundry and that further remediation to replace the wall material was required. Pseudoephedrine was also detected in surface wipe samples.

Testing of ceiling tiles in the home was undertaken by the School of Chemical Sciences, Auckland University. The level of methamphetamine absorbed in paint on the ceiling tiles was reported to be 14 µg/g paint, and the level reported in the ceiling panel softboard was 2 µg/g (58). Analysis of the ceiling paint also detected n-formylmethamphetamine.

Validation testing conducted in 2010 indicated the following:

- No detections of VOCs in air inside the home
- No detectable surface residues of methamphetamine were reported (from swabs analysed by modified NIOSH 9106 method) above the limit of detection, which was approximately 0.01 µg/100 cm^2.

Health information

The owner has provided medical reports and letters from others who have visited the property. The health issues reported in this information are summarised below:

Owner:

The owner first reported health issues to a doctor within days of moving into the property in August 2008 when undertaking renovations (including lighting the fire in the property). The health issues reported were respiratory issues (chest and sinus), skin irritation and boils on her back, fatigue, headaches and dizziness.

Health problems continued and were again reported to a doctor in October 2008 and included respiratory issues (problems breathing), headaches, extreme fatigue, dizziness, clumsiness, sore eyes, skin rashes and irritations.

The above health issues continued while living and renovating the home prior to completion of the second and final round of remediation.

Once the property was found to be a former methamphetamine drug laboratory medical testing was undertaken for drugs in urine in November 2008. No detections of amphetamines were reported in urine (test cut-off limit not stated in report provided). It is noted that the testing was undertaken at least 9 days after she had moved out of the home, which is outside the window of detection for amphetamines in urine.

In January 2009 the home owner reported acute abdominal pain (laparoscopic surgery did not find any cause).

From mid-2009 the owner has also reported increased difficulty sleeping.

The long periods of being unwell affected the home owner's ability to work with a large number of absences. She also reported depression and anxiety, believed to be associated with the level of stress.

Ongoing health issues remain that include lack of concentration, disorganised, confused, inability to deal with stress or conflict, withdrawn, depression, lowered immune system and chemical sensitivity particularly to products containing acetone and some perfumes.

The health effects reported by the occupant are summarised in **Table 20**.

Table 20 CS03: Summary of Health Issues Reported by Participants

Participant	Health effect reported							Comments
	Persistent cough	Asthma	Skin problems	Watering eyes	Sore eyes	Trouble sleeping	Unusual behaviour	
Female aged 54 years	Y		Y	Y	Y	Y	Y	Respiratory issues included chest infections and sinus problems. Skin irritation and rashes (including boils). Other health problems included headaches, fatigue, dizziness and clumsiness, lack of concentration, inability to deal with stress or conflict, withdrawn, depression, anxiety and chemical sensitivity.

A medical assessment in relation to environmental exposures in the home was undertaken in September 2009. This evaluation identified the difficulty in determining a cause of the range of non-specific health problems reported, particularly where actual exposure levels to toluene in air or methamphetamine residues are not well defined.

An assessment was further conducted by a toxicologist in June 2014 indicated that "*it has been confirmed that the house in which [CS03] became ill was used as a clandestine drug laboratory prior to her occupancy. The cleaning work she undertook in the house would be expected to result in significant exposure and absorption of methamphetamine and related chemicals. Based on the extensive information provided to me, I consider that the dramatic decline in [CS03] health, culminating in her inability to work because of injury to her concentration, executive memory and psychiatric status, is highly likely to be the result of her unwitting exposure to methamphetamine and chemicals of its manufacture, and I consider it implausible that her symptoms are unrelated to that exposure*".

As part of proceedings for compensation against the Council for injury, the Council's Toxicology Panel reviewed the available information and in a report dated 17 November 2014 concluded that

the "*low levels of methamphetamine were not a plausible cause of [CS03] multiple, non-specific symptoms, The consensus was that although VOCs may have accounted for respiratory and/or allergenic symptoms they were not a plausible cause of headaches, dizziness and fatigue*". "*The Panel was unable to relate her symptoms to the low level of contamination found in the dwelling*" and her ongoing symptoms "*were much more likely to relate to her depressive illness than to chemical poisoning*".

Visitors:

- A friend who assisted with cleaning of the home in September 2008 reported tingling and itching around her mouth only while in the home
- A friend who assisted with renovations in 2009 (after the 1st round of remediation) noted extreme lethargy for a few days after the work was done.

8.4.4 Discussion

As this case study primarily relates to issues identified from 2007 to 2010 it predates many of the current guidelines that would normally be followed for the assessment and remediation of former clandestine drug laboratories.

At the time when the clandestine laboratory was first identified by Police (2007), policies were available for Councils to ensure the properties were assessed and remediated following notification from Police. Unfortunately in this case a lack of understanding in relation to the information provided by Police resulted in the presence of the former drug laboratory not being properly assessed and remediated when first identified and the property not being notified to the purchaser.

Limited information is available on the actual levels of VOCs or methamphetamine residues in the home at the time of purchase. Much of the earlier sampling was undertaken prior to the availability of laboratory methods for the quantification of drug residues to a low level. The earlier testing undertaken on this property involved preliminary testing that could only confirm the presence of methamphetamine in surface resides that were > 10 µg. The area over which this sampling occurred is not stated. If it was over a 100 cm^2 area then the preliminary sampling identified level of contamination that would be considered to be significantly elevated above the guideline level of 0.5 µg/100 cm^2. The level of methamphetamine absorbed in paint on the ceiling tiles was reported to be 14 µg/g paint.

As methamphetamine residues penetrate many building materials it is expected that elevated exposures may occur during home renovations. This is consistent with elevated exposures that occur during renovations where lead paint and asbestos are present (233-235). For these issues the contamination is bound within the building materials themselves resulting in elevated

exposures where these materials are disturbed and subject to mechanical disturbance during renovations.

The actual level of exposure that may have occurred during renovations and cleaning at the property evaluated in this case study cannot be determined due to the limited information available on the contamination levels throughout the home. However the health information provided has identified a range of health effects that appear to be associated with living in and renovating the home.

8.5 CS04 Short-Term Rental of Methamphetamine Affected Property

8.5.1 Background

A family with two small children (aged 2 and 3 years at the time of this study) rented a property (2 storey home) as a private rental through a friend. Within days of moving into the property the neighbours told them the previous tenant has been involved in manufacturing methamphetamine in another house across the road and were involved in court proceedings. The neighbours did not know if their home had been used to manufacture methamphetamine or if the tenant only used methamphetamine in the house. However the neighbours felt they had a duty to tell the family of the history of the tenant as they noticed they had two small children.

The mother contacted the landlord to find out what had occurred in the property with the former tenant and was told conflicting information that ranged from denying any methamphetamine problems to admitting that both houses had been tested for methamphetamine contamination but no results were provided to the family. The landlord stated that the house they rented had been professionally cleaned and since they had picked up the keys from the cleaners (and saw a receipt for the cleaning works) they believed that the house was safe to live in. The mother had bleached the walls on moving in, and cleaned regularly (sometimes vacuuming 2 times a day).

Within days of moving into the property the youngest child (aged 2 years) became unwell with breathing problems and did not sleep. She continued to be unwell in the home with the local doctor suspecting that the cause of the respiratory problems was the home (knowing it was a former methamphetamine affected property) but could not confirm or be conclusive in relation to the cause.

Given the poor health of their youngest child the family became more suspicious of the information they were given by the landlord. They organised to get the property tested for methamphetamine contamination. The company engaged to test the home was the same company involved in collecting the original samples prior to moving in. The testing undertaken on the home indicated the property remained contaminated, at much the same level as prior to cleaning (and moving in), and was unsuitable for occupancy.

Once they discovered the home was contaminated they organised to move out of the home. They lived in the home for approximately 5 weeks.

8.5.2 Data Collection Methods

The participants involved in this case study included the mother and two children, and her brother, all of whom lived in the methamphetamine affected property.

The participants provided informed consent for the following:

- access to data collected for the assessment of contamination in the property
- information on the health of her and her children via interview and completion of a questionnaire
- completion of a behavioural assessment questionnaire for her children, using BASC-2 PRS forms for children aged 2 to 5 years (refer to **Section 8.2.3** for details on the BASC-2 assessment)
- collection and analysis of a hair sample from the youngest child (in accordance with the sampling method outlined in **Section 7.2** and analysis in accordance with the method outlined in **Section 7.3**).

Results for this case study have been identified using the prefix CS04.

8.5.3 Results

Environmental Contamination

Information on the level of environmental contamination from surface residue testing in the home was available from sampling conducted prior to moving into the home, and prior to professional cleaning, as well as while living in the home after being professionally cleaned. The sample collected during both sampling events was a composite surface wipe sample, from a number of locations in the home, with quantitative analysis by Hill Laboratories, and independent laboratory in New Zealand using a modified NIOSH 9111 (LC-MS/MS) method. The results of the contamination tests are summarised in **Table 21**.

Table 21 CS04: Summary of Surface Residue Levels Reported in Home

Sampling event	**Results of surface residue levels – composite sampling from approximately 100 cm^2 (µg)**			
	MA	**AMP**	**PSE**	**EPH**
Prior to moving in, prior to cleaning conducted by landlord	8.3	0.18	0.10	0.03
While living in home, after cleaning	7.3	0.36	0.34	0.06

MA = methamphetamine
AMP = amphetamine
PSE = pseudoephedrine
EHP = ephedrine

Health Information

The health issues reported by the participants, while living in the methamphetamine affected property, are summarised in **Table 22**.

Table 22 CS04: Summary of Health Issues Reported by Participants

Participant	Health effect reported							Comments
	Persistent cough	Asthma	Skin Problems	Watering eyes	Sore eyes	Trouble sleeping	Unusual behaviour	
Mother (aged 23 years)	Y	Y			Y	Y		Prior to living in the home she only had seasonal asthma, however asthma was trigger while living in the home and now is required to use medication every day even after moving out of the home. Other respiratory problems include sinus problems. Other health issues have not persisted after moving out of the home. She has reported that is has been difficult re-establishing sleep patterns after living in the home, where she and others in the home had trouble sleeping.
Child (female, aged 2 years)	Y			Y	Y	Y	Y	Breathing and wheezing issues were significant particularly at night-time. She was seen by a doctor on a number of occasions in relation to the respiratory problems that included chest infections, trouble breathing and sinus problems. She was reported to be more irritable, crying more often and aggressive while living in the home. The health issues only occurred while living in the home (including the sleep problems). Once out of the home the health problems did not persist. She is now considered to be healthy.
Child (male aged 3 years)	Y				Y		Y	He was reported to be more irritable and aggressive, particularly during play-time. The mother indicated that this child was much less affected than the younger child. None of the above health observations continued after moving out of the home. He is currently considered to be healthy.
Brother (aged 24 years)	Y					Y		He also reported persistent fatigue while in the home. These health problems started within a week of moving into the home and stopped within 3-4 days after moving out of the home. He is currently heathy.

The mother also noted that others who came to stay at the house experienced blocked sinuses and breathing problems at night-time.

Behavioural Assessment

The BASC-2 PRS forms were completed by the mother for both children and the responses evaluated using the online scoring system Q-global. Clinical analysis of the responses was undertaken with comparison against responses from a general population group to provide an indication of how the observed behaviour of the children compares with what is expected in a normal population of children.

Table 23 presents a summary of the results of the BASC-2 assessment for each of the children involved in the study. The assessment has been undertaken in June 2015 in relation to the current observations of the children's behaviour (having been out of the rental property for approximately 1 month).

The table presents a summary of the T-score and percentile for each category/sub-category and where this places the behaviour within the normal range for children of the same age, or if the score indicates the child may fall into one of the following areas:

- At-risk: may identify a significant problem that may not be severe enough to require formal treatment or may identify the potential of developing a problem that needs monitoring
- Clinically Significant: high level of maladjustment that usually requires follow-up

For the youngest child (aged 2 years), a number of sub-categories have been scored as at-risk or clinically significant. These aspects relate to depression and somatisation, hyperactivity and attention.

Behaviours reported by the older child (aged 3 years) were less significant than for the younger child, but clinically significant issues associated with anxiety were identified.

The mood and behavioural issues identified may be related to living in the rental property where sleep problems was one of the most significant issues for all members of the family.

The results of the behavioural assessment have been provided to the mother with recommendations for follow-up assessments.

Table 23 CS04: Outcomes of Behavioural Assessment, BASC-2-PRS

Category/sub-category	Results for Each Child in Study: T-score [percentile] and whether normal for age	
	CS04F2	**CS04M3**
	June 2015	**June 2015**
Age	2	3
Gender	female	male
Test validity	acceptable	acceptable
Externalising Problems		
Hyperactivity	77 [98] clinically significant	52 [66] normal
Aggression	57 [79] normal	47 [42] normal
Composite scale	69 [95] at-risk	49 [55] normal
Internalising problems		
Anxiety	61 [86] at-risk	79 [99] clinically significant
Depression	85 [99] clinically significant	68 [95] at-risk
Somatization	107 [99] clinically significant	66 [93] at-risk
Composite scale	95 [99] clinically significant	78 [99] clinically significant
Behavioural Symptoms Index		
Atypicality	72 [96] clinically significant	42 [19] normal
Withdrawal	60 [84] at-risk	64 [91] at-risk
Attention problems	67 [95] at-risk	58 [79] normal
Composite scale	77 [90] clinically significant	57 [78] normal
Adaptive Skills		
Adaptability	40 [18] at-risk	29 [1] clinically significant
Social skills	46 [36] normal	52 [56] normal
Activities of daily living	54 [64] normal	67 [97] normal
Functional communication	46 [36] at-risk	60 [82] normal
Composite scale	46 [33] normal	53 [60] normal
Content Scales		
Anger control	78 [99] clinically significant	60 [84] at-risk
Bullying	63 [90] at-risk	44 [29] normal
Developmental social disorders	60 [85] at-risk	51 [59] normal
Emotional self-control	75 [98] clinically significant	58 [82] normal
Executive functioning	75 [98] clinically significant	54 [69] normal
Negative emotionality	72 [97] clinically significant	65 [92] at-risk
Resilience	36 [9] at-risk	36 [9] at-risk
Clinical indexes		
All clinical probability	64 [91] potential	52 [62] normal
Functional impairment	66 [94] potential	50 [53] normal
Clinical summary	Clinically significant depression and somatisation scales and at-risk anxiety indicating potential internal sadness or irritability and anxiety. While these emotional aspects are common in young children they are more severe and may be associated with irritability, lack of sleep and restlessness. Clinically significant hyperactivity and attention problems scales, suggesting some behavioural problems. Mood and behavioural aspects require follow-up.	Clinically significant anxiety scale suggestive of internal worry or nervousness. Also at-risk depression and somatisation scales suggesting feelings of sadness or irritability. While these emotional aspects are common in young children they are more severe and may be associated with irritability, lack of sleep and restlessness. Emotional and behavioural aspects identified require follow-up.

Hair Analysis

A hair sample was collected from the youngest child, a female aged 2 years with blond hair. The older child did not have sufficient hair for sampling. The youngest child was living in the home for a period of approximately 5 weeks, and had moved out of the home for approximately 5 weeks when the sample was collected. The hair was cut approximately 0.5 to 1 cm from the scalp and the sample selected for analysis was selected to be 1.5 cm from the cut end to try to capture the period of exposure in the home.

Table 24 CS04: Results of Drugs in Hair Analysis – June 2015

Sample ID	Age	Gender	Length (cm)	Sample divided	Cut length (cm)	Weight analysed (mg)	Drugs found
CS04F2	2	Female	12-13	no	1.5	19.95	negative
						Hair wash	negative

No drugs were detected in the hair wash or hair analysis undertaken on the segment selected for analysis.

8.5.4 Discussion

This case study involves short-term exposure by a family with young children in a rental property. The property, whether used for the smoking or manufacture of methamphetamines was known to the neighbours. The neighbours felt that they had a duty to inform the tenants of the likely history of the property because they were concerned about the health of young children living at the property. This information prompted enquiries into contamination levels in the home, testing of the home and is the reason why the exposure time in the home was limited to approximately 5 weeks. No information was provided to the tenants by the landlord prior to moving into the home, that the property was known to have been contaminated with methamphetamine. While the property had been tested prior to the tenants moving in, no remediation was undertaken in accordance with available guidance and no validation testing was undertaken. None of the testing results were provided to prospective tenants.

During the 5 week period of living in the home, all members of the family reported health effects. All reported respiratory issues that included a persistent cough and sinus problems. In addition all members of the family reported problems in sleeping at the home. The most significantly affected was the youngest child who experienced significant breathing difficulties, trouble sleeping, irritability, aggression and issues associated with mood (depression and somatisation) and behaviour (hyperactivity and attention). Some of the behavioural issues may be associated with the lack of sleep reported to have occurred while living in the contaminated home, which also continued for some time after moving out of the home.

Analysis of hair from the youngest child did not detect methamphetamine or amphetamine. This may be due to the short duration of exposure (approximately 5 weeks) and issues with identifying the segment of hair that related to this period of exposure. The segment of hair identified for analysis was based on the assumption that hair grows approximately 1 cm per month. However it is noted that hair growth rates can vary from 0.6 to 3.36 cm per month, with the majority of studies reporting growth rates between 0.6 to 1.5 cm per month (191). In addition it is noted that it takes approximately 7 to 10 days for the growing hair to reach the surface of the scalp. Hence hair cut from the scalp does not represent the most recent growth period (191). It is likely that the testing of hair did not capture the period of exposure. This issue could be addressed in future sampling and analysis by conducting a number of segmented analyses of the hair sample.

8.6 CS05 Exposure in Methamphetamine Affected Rental Property

8.6.1 Background

A family (mother and 2 female children) and carer (adult female) lived in a rental property that was known to have been affected by methamphetamine contamination.

The property was initially tenanted by the family's mother who had a history of drug use, including heavy use (including smoking) of methamphetamines. During her time living at the property (more than 10 years) she took in a number of boarders, some of whom were also drug users. The property was affected by methamphetamine contamination primarily as a result of the long-term smoking of the drug. However there is a strong suspicion that the property may have also been used for the manufacture of methamphetamine by boarders staying at the property. The property was never seized by Police for the manufacture or use of methamphetamine.

The family (and carer) regularly visited the home while the mother was living in the home. In the months leading up to the mother passing away, the daughter organised to transfer the property lease to include her name. The family and carer moved into the home approximately 1 month prior to the mother passing away. They lived at the home for approximately 3 years until March 2015.

The mother (daughter of the original tenant) was a former drug user and had health issues that required a carer to reside with her.

After moving into the home, all the members of the family and the carer experienced health problems. The health problems were initially put down to grieving. However the health problems continued. In early 2015 the property owner decided to evaluate the home for methamphetamine contamination and determined it was not suitable for occupancy. The family and carer were told to leave the property, leaving their property in the house. They have since been rehoused in another property but are not permitted to access their property in the contaminated home. Further sampling has been undertaken in the home, including possessions.

While the property the family was living in was affected by methamphetamine contamination primarily from drug use, rather than from the manufacture of methamphetamine (though manufacture is suspected), the case study provides valuable information in relation to levels of contamination and health effects experienced while living in such a property. Smoking methamphetamine is not the burning of methamphetamine, rather it is the heating of methamphetamine until it becomes an inhalable aerosol (55). The aerosols/residues that are produced and deposited during smoking of methamphetamine are considered to be the same as those produced during the manufacture of methamphetamine, i.e. from deposition of methamphetamine aerosols (48). Hence the case study is of value in providing information on contamination levels and health effects associated with exposures in such a property. In addition the case study provides insight into issues associated with contamination from former methamphetamine drug use. Properties that may have been used for smoking methamphetamine are not often identified, assessed and remediated, yet still may pose a health risk to future occupants.

8.6.2 Data Collection Methods

The participants involved in this case study included the mother and her youngest child (aged 13 years) and an adult carer, all of whom lived in the methamphetamine affected property.

The participants provided informed consent for the following:

- access to data collected for the assessment of contamination in the property – permission was also obtained from the property owner for access to contamination assessment data collected at the property
- information on the health of the carer, the mother and her child via interview and completion of a questionnaire
- collection and analysis of a hair sample from the youngest child (in accordance with the sampling method outlined in **Section 7.2** and analysis in accordance with the method outlined in **Section 7.3**).

Results for this case study have been identified using the prefix CS05.

8.6.3 Results

Environmental Contamination

Information on the level of environmental contamination from surface residue testing in the home and garage was available from sampling conducted in February 2015 for the purpose of testing for contamination and remediation. The samples were collected using methanol wipes over an approximate area of 100 cm^2 with quantitative analysis by Forensic and Industrial Science Ltd in New Zealand using a GC-MS method. Results for methamphetamine contamination were reported. The results of these tests are summarised in **Table 25**.

The contents in the home were tested in March 2015. Only possessions with hard surfaces were tested using methanol wipes over an approximate area of 100 cm^2 with quantitative analysis by Forensic and Industrial Science Ltd in New Zealand using a GC-MS method. The results of these tests are summarised in **Table 26**.

Table 25 CS05: Summary of surface contamination levels in home

Sampling location	**Results of surface residue levels (µg/100 cm^2)**
	Methamphetamine
Living room/lounge wall	3.57
Kitchen cabinet	12.1
Dining room ceiling	20.7
Laundry	0.08
Bathroom and toilet	0.07 to 1.23
Hallway	16.3
Bedroom 1	0.17
Bedroom 2	0.11
Bedroom 3	3.56
Garage	<0.03 to 0.06
Hallway ceiling insulation	Testing of building material = 0.01 µg/g

Table 26 CS05: Summary of surface contamination levels on possession in home

Sampling location	**Results of surface residue levels (µg/100 cm^2)**
	Methamphetamine
Lounge/dining table	0.05
Lounge shelving	0.04
Lounge couch	0.29
Lounge television	<0.03
Bedroom 1 table	<0.03
Bedroom 1 chest of drawers (timber)	6.13
Bedroom 2 cabinet (timber)	7.13
Bedroom 2 bed frame (timber)	0.03
Bedroom 3 television	0.94
Bedroom 3 children's board game	<0.03
Garage shelving, cabinets and dehumidifier	<0.03 to 0.33

In contrast to the previous case study in a rented premises (CS02) the furniture in this home was a mix of items that were brought into the home and others that were in the home prior to occupancy when methamphetamine use occurred. Information was not available on which items of furniture were present during the period of methamphetamine use.

Health Information

It is noted that both the carer and mother are former drug users (including use of methamphetamines). Both have been in a long-term drug rehabilitation program (that include the use of methadone). Illicit drug use ceased well before moving into the home. Neither were involved

in the use of methamphetamines while living in the contaminated property. However both were aware of the effects of methamphetamine drug use and have described many of the health effects from living in the home as similar to withdrawal from amphetamines, but continual.

The health issues reported by the participants, while living in the methamphetamine affected property, are summarised in **Table 27**.

Table 27 CS05: Summary of Health Issues Reported by Participants

Participant	Health effect reported							Comments
	Persistent cough	Asthma	Skin Problems	Watering eyes	Sore eyes	Trouble sleeping	Unusual behaviour	
Mother (female aged 34 years)	Y	Y	Y			Y	Y	Skin problems included dry patches and a rash. Also reported was extreme fatigue and weight gain (from lack of activity). Even when sleeping a lot, never resolved the fatigue. Behavioural issues reported were irritability, moodiness and depression. She reported that she found it hard to leave the house and when she did, she felt anxious about being out and wanted to get back home. She would often forget to eat. The health problems experienced in the home improved after moving out. Energy levels returned within a month of moving out.
Child (female aged 13 years)	Y	Y	Y	Y	Y	Y	Y	Significant respiratory problems were reported. She never had asthma before moving into the home, but experienced breathing difficulties (all the time but particularly at night) and asthma when in the home. She was unwell with infections and hay-fever-like symptoms (including sore and watering eyes). The hay-fever symptoms were not associated with seasons or other triggers. Her behaviour was reported to change in the home, described as erratic varying between aggressive, confrontational and depressed (with very quick changes in mood). She was always tired and lethargic (normally active) and did not want to go to school. Some of her behaviour was put down to adolescence but the problems were very different from her normal “bubbly” personality. Her health improved on moving out of the home and her behavioural problems have been resolving. She has become more active again and wants to go to school. She is currently considered to be generally healthy.
Carer (female aged 44 years)	Y	Y	Y			Y	Y	She reported being short of breath doing simple tasks and trouble breathing particularly at night. She also reported experiencing hay-fever like symptoms. Skin problems included dry patches and exacerbation of eczema. Other problems included fatigue, irritable, moodiness and headaches. Previous problems with circulation in her hands occurred while living in the home. Since moving out of the home her health has improved (particularly after a month) and she is not as lethargic and tired. She can better handle social situations.

Hair Analysis

A hair sample was collected from the youngest child, a female aged 13 years with long black hair. It was indicated that she had moved out of the home approximately 3.5 months prior to the collection of the hair sample. She had lived in the contaminated property for approximately 3 years. The hair sample was cut approximately 1 cm from the scalp and the initial sample (3 cm in length) selected for analysis was selected to be approximately 2 cm from the cut end to try to capture the period of exposure in the home.

Analysis of initial hair segment did not detect methamphetamine. Further discussions with the family suggested that the dates provided for exposures in the home may not have been accurate for the youngest child as she spent time living out of the home with her older sister prior to the rest of the family vacating the home. Hence an additional hair segment (3 cm in length) was selected for analysis. The additional sample was cut an additional 3cm from the end of the previous sample (i.e. a total of 8 cm from the cut/scalp end of the sample) and analysed.

Table 28 presents the results of the hair analysis undertaken for this individual.

Table 28 CS05: Results of Drugs in Hair Analysis – June 2015

Sample ID	Age	Gender	Length (cm)	Sample divided	Cut length (cm)	Weight analysed (mg)	Drugs found	Concentration (pg/mg)
CS05F13	13	Female						
First hair segment – 2 cm from cut end			35	no	3	21.19	methadone	**11**
						Hair wash	methadone	**8**
Second hair segment – 8 cm from cut end			35	no	3	20.74	methadone	**32**
							methamphetamine	**8**
						Hair wash	methadone	**20**

Analysis of the second hair segment, considered to be more representative of exposures inside the home, detected methamphetamine at a level of 8 pg/mg in the hair matrix. This reflects a low level environmental exposure to methamphetamine residues identified in the home.

Methadone was also detected in the hair samples analysed, both in the hair wash (from external deposition) and in the hair matrix. Methadone concentrations in the hair of individuals in methadone treatment programs are generally in the range of 1 to 50 ng/mg (or 1,000 to 50,000 pg/mg) (236), significantly higher than the concentrations reported in this case study.

8.6.4 Discussion

This case study involves exposure by a mother, carer and teenage daughter within a rental property that is most likely to have been contaminated by methamphetamine during smoking, rather than manufacture. The mechanism of methamphetamine contamination in a home used for smoking is understood to be the same as for manufacture (48) and the levels of environmental contamination reported in the home are within the range reported in homes contaminated from methamphetamine manufacture. Analysis of a hair sample from the teenage daughter that reflects a time period of exposure in the home reflected a low level of methamphetamine incorporated into the matrix of the hair. This reflects low level environmental exposures that are likely to occur in older children, who are much less likely to come into regular contact with surfaces in the home and wash their hands before eating.

The mother and carer are former drug users and were aware of the likely presence of methamphetamine contamination in the home. Both these individuals remain on a methadone treatment program. Analysis of hair samples collected from the teenage daughter reported low level detections of methadone in both the hair wash and incorporated into the hair matrix. Low levels of methadone are often detected in the hair of children living with parents on methadone maintenance treatment, potentially as a result of adult-child contact (237). Given the detection of low levels of methadone in both the hair wash and the hair sample it is expected that the results reflect past and present environmental/passive exposures in the home associated with the methadone treatment program.

During the 5 week period of living in the home, all members of the family reported health effects. All reported respiratory problems, skin problems, trouble sleeping that also resulted in extreme fatigue and behavioural changes. The respiratory symptoms were noted to be more significant in the teenage daughter, described as breathing difficulties, asthma-like symptoms and increase susceptibility to upper respiratory tract infections. The teenage daughter also reported sore and watering eyes that may have also been associated with symptoms of various respiratory infections. The behavioural issues reported included erratic changes in behaviour varying from aggressive, confrontational to depressed. Other changes were noted to be fatigue and headaches. As the mother and carer were former users of methamphetamine they both related the health effects experienced while living in the contaminated home to be similar to methamphetamine withdrawal, however the effects were constant.

8.7 Summary of Opportunistic Case Studies

Each of the case studies presented in this research provides valuable information and data on actual levels of exposure and health effects experienced by the public when exposed to contamination that remains in a home following the manufacture or use of methamphetamine. While the exposure situations differ in each of the case studies, there are common observations that are of importance in relation to characterising and understanding exposures and health effects. **Table 29** presents a summary of the key aspects and findings of these case studies.

The data summarised in **Table 29** indicates individuals exposed to environmental methamphetamine contamination inside a residential home, with maximum surface residue levels in the range of 7.3 to 42 μg/100cm^2, have reported a range of health effects associated with exposures that occurred only within the home. These exposures relate to contamination that remains in homes formerly used, or suspected to have been used, for the manufacture of methamphetamine and the smoking of methamphetamine. In addition, similar health effects have been reported in a home that was formerly used for manufacture and was remediated, primarily by encapsulating contamination with new paint. Exposures then occurred during and following remediation where contamination was remobilised within the home. The case studies present a range of evidence obtained from self-reported health information, the completion of BASC-2 behavioural checklists and data from the analysis of hair samples to support the outcomes identified in relation to exposure and health effects.

Table 29 Summary of Key Aspects and Findings of Opportunistic Case Studies

CS01	CS02	CS03	CS04	CS05
Exposure situation				
Family unknowingly purchased and lived in a home formerly used to manufacture methamphetamine	Family unknowingly renting a house formerly used to manufacture methamphetamine. Some attempt at cleaning and replacement of curtains had occurred prior to occupancy	Purchase of a home unknowingly to have been formerly used to manufacture methamphetamine. The property underwent remediation during occupancy however renovations resulted in recontamination	Family unknowingly rented a home that was formerly used to manufacture methamphetamine. Some attempt to clean the home was undertaken prior to occupancy	Family exposed to methamphetamine contamination, most likely to be as a result of former smoking of the drug. Manufacturing may have also occurred. The family knew the home was used by drug users prior to occupancy and the adults were former drug users
Number and age of individuals exposed at the time of this study				
2 adults, aged 38 and 40 years 3 children aged 7, 8 and 11 years	1 adult aged 44 years 2 children aged 12 and 17 years	1 adult aged 54 years	2 adults aged 23 and 24 years 2 children aged 2 and 3 years	2 adults aged 34 and 44 years 1 child aged 13 years
Duration of exposure				
Approximately 18 months	Approximately 4 months	Approximately 2 years	Approximately 5 weeks	Approximately 3 years
Level of environmental contamination, methamphetamine surface residues				
Outdoor shed: 0.59 to 64.7 µg/100 cm^2 Inside home: 11.7 to 26 µg/100 cm^2	Upstairs: 0.02 to 0.78 µg/100 cm^2 Downstairs: 0.07 to 42 µg/100 cm^2 Possessions: 0.02 to 0.16 µg	Limited data available. Initial testing indicated surface residues > 10 µg After remediation: 0.01 to 2 µg/100 cm^2 Levels in ceiling paint: 14 µg/g paint	Prior to occupancy: 8.3 µg/100 cm^2 During occupancy: 7.3 µg/100 cm^2	Home: 0.11 to 20.7 µg/100 cm^2 Possessions: <0.03 to 7.13 µg/100 cm^2
Spread of environmental contamination				
Well spread	Well spread	Not known	Insufficient data available	Some spread
Biological data to support exposure				
Hair samples collected from family immediately upon moving out of the home. Methamphetamine and amphetamine detected in the hair for the 2 youngest children at levels similar to that reported in children removed from active methamphetamine laboratories and low level adult drug users. Methamphetamine was detected in the hair of other family members at levels that reflected the level of exposure likely in the home.	Not collected	Not collected	Analysis of hair from youngest child did not detect methamphetamine. The period of exposure was short and may not have been captured in the hair segment analysed	Analysis of hair from the child detected a low level of methamphetamine. The hair analysis also detected low levels of methadone likely to be a result of environmental exposures (adult-child contact) in the home, as the 2 adults are on a long-term methadone treatment program

CS01	CS02	CS03	CS04	CS05
Re-testing of hair samples collected 3 months after exposure only detected a low level of methamphetamine in one of the hair samples from the children, likely to be associated with different hair growth rates, where the hair segment analysed likely included a period of former exposure				
Health effects reported				
Most significant health effects reported in youngest child. Effects included asthma-like symptoms and persistent cough, sore and watering eyes, skin problems, vivid dreams and unusual behaviour. Other members of the family have experienced a persistent cough, sore and watering eyes, trouble sleeping and unusual behaviour (irritability)	Most significant health effects reported in the older teenage child who lived in the downstairs area, staying in his bedroom for up to 24 hours per day. Health effects related to unusual behaviour and trouble sleeping. Other family members experienced skin problems and trouble sleeping	Owner reported respiratory issues, skin irritation, fatigue, headaches and dizziness, sore and watering eyes, trouble sleeping and changed behaviour (depression and anxiety)	Most significant health effects reported in the youngest child. Effects included respiratory problems, trouble sleeping, irritability, crying more often and increased aggression. Effects reported by other family members included exacerbation of pre-existing asthma, persistent cough, trouble sleeping, fatigue, irritability and increased aggression	Most significant health effects reported in the child. Effects included respiratory effects, and unusual behaviour. Other effects included sore and watering eyes, skin problems and trouble sleeping. Other occupants experienced respiratory problems, skin problems, trouble sleeping, fatigue and changes in behaviour. The health effects are described by the adults as similar to methamphetamine withdrawal but continual
Outcome of behavioural assessment				
Some areas categorised as at-risk or clinically significant, particularly for the youngest child where the elevated scores related to anxiety, attention issues and somatisation. The testing identified potential ADHD (inattentive type)	For the oldest child, many of the sub-categories have been scored as clinically significant. These include hyperactivity, aggression and conduct problems, depression and withdrawal, adaptive skills and content scales. For the youngest child, a number of sub-categories have been scored as at-risk or clinically significant. These aspects relate to hyperactivity, anxiety and attention issues	Not undertaken	For the youngest child (aged 2 years), a number of sub-categories have been scored as at-risk or clinically significant. These aspects relate to depression and somatisation, hyperactivity and attention. Behaviours reported by the older child (aged 3 years) were less significant than for the younger child, but clinically significant issues associated with anxiety were identified	Not undertaken

CS01	CS02	CS03	CS04	CS05
Health effects after exposure				
After approximately 3 months post exposure the youngest child had reduced frequency of respiratory problems and improvement in behavioural issues previously identified. Other children had some changes in behaviour likely to be associated with the family being excluded from their home and possessions	The unusual behaviours reported did not continue after moving out of the home	Continued to suffer from depression and chemical sensitivity	Most of the health effects observed resolved after moving out of the home. Re-establishing normal sleep patterns and an increase susceptibility to asthma remain an issue for the mother (aged 23 years)	The health of the occupants improved upon moving out of the home with most of the health effects resolving within a month
Value of case study				
Provides co-located data on environmental contamination, biological data in relation to exposure and health effects. The case study also provides information on issues associated with the current management of former clandestine drug laboratories by local Councils in Australia, particularly in relation to property transfers and notification of contamination	Provides co-located data on environmental contamination and health effects where a family has been exposed to contamination in a rental property for less than 6 months. The case study also highlights some of the issues associated with renting a property formerly used to manufacture methamphetamine	Provides information on potential exposure and health issues associated renovating former clandestine drug laboratories	Provides co-located data on environmental contamination and health effects for a short-term rental situation where young children are present. The case study illustrates the increased level of concern shown by neighbours who suspected a former clandestine drug laboratory, where young children may be exposed	Provides co-located data on environmental contamination, biological data and health effects. The data suggests there is no discernible difference in exposure and health effects between contamination derived from smoking or manufacturing the drug. The observations on health effects provided by former drug users a unique perspective, where these are described as similar to methamphetamine withdrawal but continual

PART C: REVIEW AND APPLICATION OF INFORMATION AND DATA

9.0 RISK ASSESSMENT

9.1 Introduction

Sections 5 to 8 present both qualitative and quantitative information and data derived from different data collection methods from different groups of individuals. To be able to further review these data, risk assessment techniques have been used to evaluate the significance of the information and data collected in this study in relation to characterising exposure and potential health effects.

9.2 Approaches used to Assess Risk

Guidance is available in Australia in relation to the approaches that may be considered in assessing risks to human health associated with environmental exposures (138). This guidance allows for the assessment of risk to be undertaken using either or both qualitative and quantitative methods. The suitability of approaches adopted for the assessment of risk depends on the availability, reliability and type of information that can be used to understand and characterise exposure and hazards posed by exposures.

A quantitative risk assessment utilises parameters and assumptions to quantify the amount of a chemical that gets into the body from various different exposure pathways, utilises a quantitative toxicity reference value that defines the relationship between an intake of a chemical into the body and adverse health effects and then enables a calculation of the potential for (or risk of) adverse health effects occurring.

A qualitative risk assessment utilises other non-quantitative information/measures to better understand the mechanisms (knowledge of and/or potential) by which an exposure can occur, the significance/ranking of various exposure pathways or activities and/or the potential for adverse health effects to occur as a result of exposure. It is often difficult to accurately rank risks posed by environmental contamination, however qualitative techniques can provide enable exploration of key aspects (including social, behavioural and process) that can affect exposure and the potential for adverse effects to occur.

A quantitative risk based approach was used in the development of the guidelines for the assessment and remediation of former clandestine drug laboratories (3, 13). For example the quantitative guideline of 0.5 µg/100 cm^2 developed for methamphetamine on indoor surfaces in a residential property is based on:

- Quantification of exposure: where the intake of methamphetamine by a young child is calculated (as these exposures are most significant) on the basis of a number of parameters or assumptions used to calculate intakes that occur from dermal contact with hard and soft surfaces and ingestion of residues on hands and from mouthing of objects. The quantification of exposure assumed that the property had been remediated to remove dusts and other contamination that could become re-suspended in the air, and that "reservoirs" of methamphetamine contamination, such as contaminated air conditioning filters and ducts and fans, are not present (49).
- Quantification of the hazard/toxicity of methamphetamine for exposures by the general public. The quantification of toxicity is based on a sub-chronic toxicity reference value from a peer-reviewed evaluation (152) of 0.0003 mg/kg/day, where the most sensitive health endpoint identified was appetite suppression and reduction in body weight gain. An uncertainty factor of 300 was adopted to develop the toxicity reference value from the study. The toxicity reference value adopted was relevant to sub-chronic exposures as this was considered relevant to the nature of exposure to methamphetamine residues that are expected to decrease over time (due to degradation and removal from ongoing cleaning) after remediation has occurred in a property. The approach adopted does not specifically address situations where remediation has never occurred and exposure have the potential to occur for a longer period of time.
- Quantification of risk, where the intake of methamphetamine is compared with the tolerable intake or toxicity reference value.

The above approach does not consider exposures that occur in the situation where a property is not remediated, including potential long-term (chronic) exposures to methamphetamine.

This research has not specifically addressed any of the parameters or assumptions that may be used in the quantification of risk for such exposures.

However the information obtained provides a qualitative approach to better inform the underlying assumptions in relation to the hazards and exposures, potential for health effects and where the key risks may occur within a former methamphetamine drug laboratory. This, more broad, quantitative information can then be used to better inform and direct further efforts in refining the quantitative assessment of risk.

9.2 Hazards and Exposures during Manufacture

Interview data obtained from individuals convicted of the manufacture of methamphetamine (cooks) and Police and forensic investigators (as detailed in **Section 5**) provides information that specifically relates to the hazards and risks, and perceptions of these, during the manufacture of methamphetamine. More specifically the behaviours and attitudes of the cooks involved in the manufacture of methamphetamine give an insight into aspects that have the potential to affect the level of risk to the cook as well as all others who live in or visit the property.

Based on the interview data obtained the following can be observed in relation to risks/hazards during manufacture:

- The most common locations for the manufacture of methamphetamine are residential homes, units, townhouses and sheds or garages. In addition manufacture at outdoor/bush sites is also common, particularly in Western Australia.
- Where manufacturing occurs in a home, it mostly takes place in a kitchen, bathroom or bedroom. These locations are expected to be associated with the highest level of exposure and risk.
- Most of the cooks interviewed as part of this research were involved in the manufacture of methamphetamine for personal use. Hence the attitudes, perceptions and understanding of risks are affected by drug use. In fact most of those interviewed specifically did not protect themselves against exposure so they could get high (via inhalation) from the manufacture in addition to normal use. As a result many of the health effects reported by the cooks relate to personal use as well as acute effects from exposure to chemicals and gases when not wearing any protective clothing or equipment. The health effects reported/observed include:
    - Skin problems (mainly chemical burns), sore and watering eyes, cough and asthma and general poor health experienced during and immediately after the cook. Behaviours observed of drug cooks included aggression, violence, energetic, fidgety and depressed; and
    - Trouble sleeping (mainly from drug exposure during the cook), skin problems and sore eyes persisting after the cook. Many of these effects resolve within days, or a few weeks for some skin burns.
- Most of the cooks were aware that the manufacture of methamphetamine is associated with a whole range of hazards (including fire, explosion and the presence of toxic fumes, acids and alkalis) however most do not perceive these as a risk to themselves and others as they think most of the chemicals used/stored are common chemicals typically found in homes and workplaces, such as car workshops. Most do not see any reason to take any special precautions with the storage or use of these chemicals. Most stated that they would store

the chemicals in the home or shed (consistent with observations from Police and forensic investigators) where they can pose a risk to other occupants or visitors if not stored properly. Police observations indicate that in most cases there was no care taken with the storage of acids and alkalis and that they often found chemicals stored throughout a home, sometimes hidden. Some cooks indicated that they stored chemicals in other locations outside of the home/property (with friends or buried) to avoid detection or minimise losses if caught.

- When undertaking the cook, most of the concern relates to secrecy (being found out). Hence the changes made to the premises more specifically relate to minimising the chance of being caught rather than minimising exposure. These changes involve shutting up the home and using fans or air conditioning in the home to extract gases/fumes, and in some cases cooks reported collecting gases for later release outdoors (mainly so that the gases/fumes and odours from the cook are not detected). These modifications ensure that gases/fumes/aerosols produced during the cook are kept within the home where high levels of exposure may occur. Where fans and air conditioning are used the contamination is spread throughout the home, resulting in exposures throughout the home.
- Waste generated during the cook is typically disposed of down drains or tipped onto the ground, however in some cases waste is stored for disposal at a later date (via burying, dumping or burning). Police have observed the storage of waste and, in some cases, chemicals in unmarked containers. The presence of stored waste poses a hazard to occupants and visitors to the property.
- When interviewing the cooks, information on whether other people were present, exposed and/or experienced adverse health effects, during the cook was one aspect where the answers provided were considered likely to be deceptive. A number of cooks indicated that friends and other family members were present which is consistent with observations from Police. Less than 10% indicated that children also lived in the home. This number is low compared with the observations from Police (average of 21%) and literature/other sources (approximately 20%). It is likely that the cooks are not willing to admit that children were present at the time of the cook in the interviews conducted as they may perceive that this may lead to further convictions.
- Where children were present in drug laboratories health effects were observed by Police to include poor personal hygiene, cough/asthma, burns and sore/irritated eyes.
- Police involved in the investigation of methamphetamine drug laboratories have identified that there are some situations where they have been exposed, primarily to gases, without the use of personal protective equipment. However they have procedures in place to minimise the duration of exposure and as a result very few (only acute) health effects have been reported. In addition Police investigating former methamphetamine drug laboratories are required to wear appropriate levels of personal protective equipment which minimises

long-term exposures and risks. Data on levels of drugs in hair for officers involved in active operations for the assessment of methamphetamine drug laboratories in Western Australia did not detect the presence of any methamphetamine. This data supports that the procedures adopted by Police are effective in minimising exposure and addressing the risks.

9.3 Hazards and Exposures following Manufacture

Following the manufacture of methamphetamine in a premises, hazards and risks remain at the property for future occupants and visitors. Data obtained from interviewing individuals convicted of the manufacture of methamphetamine (cooks) and Police and forensic investigators (as detailed in **Section 5**), environmental data from former clandestine drug laboratories (as detailed in **Section 6**) and from the opportunistic case studies (as detailed in **Section 8**) provide information that relates to the level of risk that remains in these premises following manufacture.

Based on the data obtained the following can be observed in relation to risks/hazards following manufacture:

- Presence of contamination and residues in a home:
    - During the cook the closing up of the home keeps contamination and residues within the home. In addition the use of fans has the potential to result in the spreading of contamination and residues throughout the home. Environmental data from properties formerly used to manufacture methamphetamine indicate the following:
        - Level of contamination: 85% of the properties evaluated reported methamphetamine residues that exceeded the residential remediation guideline 0.5 µg/100 cm^2, 56% of the properties exceeded 10 times the guideline, 28% of the properties exceeded 100 times the guideline and 5% of the properties exceeded 1000 times the guideline.
        - Spread of contamination: 83% of the properties evaluated reported some level of spread of contamination throughout a home, 58% of the properties evaluated reported wide-spread movement of contamination in the home.
    - Environmental data also indicates that:
        - The most likely location of manufacture, where contamination is most likely to remain, is the kitchen, shed/garage, bedroom, bathroom and laundry. The higher levels of methamphetamine residues were observed to be present in these areas.
        - Where VOCs were reported in air, 31% reported low levels (<1ppm) and 16% reported higher levels (>1ppm). This indicates that for some properties VOCs remain present at levels sufficient to affect indoor air quality.

        - The highest levels of methamphetamine residues were reported on indoor surfaces following manufacture using Red P/Hypo or P2P methods. It is noted that the observations reported for manufacture using the P2P method is based on data from only 5 properties.
        - The level of methamphetamine residues in homes formerly used to manufacture methamphetamine is variable, however approximately 89% of the premises evaluated had residue levels in excess of the health-based guideline, indicating that the level of residues that remain in these properties is high enough to be of concern in relation to exposure and risks to health for future occupants.
        - Where air conditioning and ventilation fans (particularly kitchen range hoods) were present the levels of methamphetamine residues reported in these systems (including filters) was elevated, at levels higher than on indoor surfaces. The presence of high levels of methamphetamine in filters/ducting and ventilation fans indicates the potential for the continual spreading of contamination to air and throughout the home through the use of these systems.
        - Contamination was observed to have spread throughout a home where there was the presence of air conditioning and ventilation systems, a fire/explosion had occurred and there was evidence of staining or powder residues. A property that was observed to be very messy (including unhygienic) was more likely to be associated with the spread of contamination in a home, however it was not a determining factor.
    - The methamphetamine residues remain for a long period of time (with significantly levels reported in one property [CS01] more than 2 years after detection of the former methamphetamine drug laboratory by Police) resulting in exposure and risks to future occupants for a significant period of time if the contamination is not remediated.
- Waste:
    - While the cooks have indicated their likely locations of waste disposal, Police observations indicate that unless waste is stored in containers or there is specific evidence (damage, staining or residues) of disposal, the location of waste disposal is often not well known after manufacture. The unknown location of waste disposal poses a hazard for future occupants as drug related waste may remain on the property. In addition drug related waste may be present in other unknown locations (other waste bins or areas) as a result of the dumping of these materials at locations off the property.

    - Where septic systems were present and tested, methamphetamine (and in some cases other chemicals used in the drug manufacture) have been detected.
    - Where soil has been tested, a limited number have reported detections of methamphetamine, iodine, phosphorus and mercury. One property reported levels of solvents (in particular ethylbenzene, xylenes, isopropylbenzene and total petroleum hydrocarbons) in soil.
- Data from the case studies evaluated in this research has indicated the following:
    - Long-term exposure to elevated levels of methamphetamine residues in a former clandestine drug laboratory (where remediation has not been undertaken, or not undertaken properly) results in levels of methamphetamine and amphetamine in the hair of young children, at levels similar to children removed from active drug laboratories (208, 230) and low level adult drug users (205, 208, 229).
    - Exposures in former methamphetamine drug laboratories is associated with a range of health effects that include respiratory effects (particularly in young children) and behavioural changes.
    - The conduct of home renovations on properties formerly used to manufacture methamphetamine has the potential to result in exposure, even where some remediation may have occurred in a property. Health effects that have been associated with these activities include respiratory effects, skin problems, fatigue, headaches and dizziness.
    - The conduct of home renovations on properties that have been remediated has the potential to result in re-contamination of the property, by remobilising contamination that may have been encapsulated in paint or other sealants (rather than removed).
    - Methamphetamine contamination may be present in homes used to smoke the drug at levels similar to those reported in former methamphetamine drug laboratories. Similar health effects have been reported by individuals living in homes contaminated with methamphetamine as a result of clandestine drug manufacture or smoking. Hence the similar levels of risks to public health are posed by these premises.

9.4 Summary of Health Effects

Table 30 presents a summary of health effects/observations associated with the manufacture of methamphetamine. The summary presents information and data obtained from interviewing cooks, Police and Forensic Investigators, and a number of case studies where individuals have been unknowingly exposed to contamination in un-remediated clandestine drug laboratories. The Table also presents a summary of other information available in the literature relevant to the exposures evaluated in this study.

Table 30 Summary of Health Effects Reported by Participants in this Study, Associated with Exposure to Methamphetamine Drug Laboratories

Reported health effects	Cooks – based on interview data (refer to Section 5)	Cooks and others – based on observations from Police (refer to Section 6)	Police and forensic investigators – based on interview data (refer to Section 6)	Residents living in un-remediated methamphetamine-affected properties (refer to Section 8)	Published Studies
Skin problems	Reported burns and skin irritation during and after the cook	Burns observed on some children from drug labs	Minor skin effects (irritation) reported	CS01: skin problems reported in the youngest child (exacerbation of existing rashes) CS02: skin problems (rashes) reported by mother and oldest child CS03: skin rashes (including boils in her back) and irritation reported during the conduct of renovations in the home. Visitors to the home at that time also reported skin irritation particularly around the mouth CS05: dry patches and a rash were reported	Chemical burns and skin irritations commonly reported by first-responders to ATS drug laboratories in the US (65, 68, 238, 239) Burns and skin problems have been reported in children who are exposed to chemicals in drug laboratories or waste dumped from the manufacture of methamphetamines (61, 74). Acute burns reported where there has been a fire or explosion (72, 83, 89, 91-96)
Sore and watering eyes	Reported during the cook with one participant reporting sore eyes following the cook. Others in the premises (not cooking) have reported eye irritation	Observed in some children from drug labs	Prior to implementation of PPE effects were reported (e.g. from caustic powder blowing in eyes)	CS01: reported by all family members CS04: sore eyes were reported by the mother for her and her children, with the youngest child also reported to have watering eyes CS05: sore and watering eyes were reported by the youngest child, potentially related to respiratory and hay fever effects also reported	Eye irritation reported by first-responders to methamphetamine drug laboratories in the US (11, 65, 68, 238)
Respiratory problems (including asthma and cough)	Reported by some during the cook (a number stated that it was only a problem at first as they got used to the fumes). Others in the premises at the time of the cook experienced respiratory problems (cough, trouble breathing)	Observed in some children from drug labs	Most had attended premises where toxic fumes were present but most wore appropriate levels of PPE or quickly removed themselves from the situation. A few officers reported minor respiratory effects from short exposures to gases	CS01: a cough has been reported by most family members. For the youngest child more significant respiratory issues described as asthma-type symptoms developed when living in the home CS03: chest and sinus problems reported during and after the conduct of renovations in the home CS04: all participants reported a persistent cough. The youngest child reported significant breathing problems and wheezing while living in the home, particularly at night-time. The breathing problems with the youngest child did not persist after moving out of the home. The mother reported that her own asthma	Acute respiratory irritation and effects such as breathlessness, coughs, sore throat and nose, wheezing and lung damage (63, 65, 68, 102, 238, 239), delayed pulmonary toxicity (40) and long-term respiratory damage (102) reported by first-responders to methamphetamine drug laboratories in the United States. Respiratory effects also reported in first-responders in Australia (86, 103-105) Effects of accidental ingestion of methamphetamine by children include acute respiratory problems (100)

Reported health effects	Cooks – based on interview data (refer to Section 5)	Cooks and others – based on observations from Police (refer to Section 6)	Police and forensic investigators – based on interview data (refer to Section 6)	Residents living in un-remediated methamphetamine-affected properties (refer to Section 8)	Published Studies
				exacerbation issues continued even after moving out of the home CS05: all occupants reported a cough and difficulty breathing. The child experienced significant respiratory effects including asthma (never experience before living in contaminated home) and persistent hay-fever like symptoms	Exposures in former methamphetamine drug laboratories include breathing difficulties reported in a 1 year old child (61) and asthma reported in another child (100) in the US Respiratory effects (sinus problems in all members of the family and breathing difficulties in newborn baby) reported in a family who lived for 5 months in a former methamphetamine drug laboratory in Utah (240)
Behavioural issues	Most were drug users and used the cook to get high and many experienced effects associated with drug exposure such as trouble sleeping, tiredness after the cook	Cooks observed to be aggressive and violent, very energetic and fidgety and depressed – these may be the result of being drug users or exposure during the cook	None reported	CS01: minor behavioural issues reported for all family members that include excess energy, trouble sleeping and irritability. For the youngest child behavioural issues were reported following exposure in the home. The behavioural issues were described as heightened fear and vivid dreams, easily distracted and inattentive. Results of a behavioural assessment BASC-2-PRS identified clinically significant somatisation and at-risk anxiety and attention problems resulting in the possibility of ADHD (inattentive type). The behaviours observed were not present prior to living in the home and appear to have diminished 3 months after exposure CS02: the oldest child, who spent most time in his bedroom (almost 24 hours per day) reported significant irritability, depression, moodiness, aggressive, non-compliant behaviour and lethargic The behavioural issues did not continue after moving out of the home CS03: fatigue, difficulty in sleeping and changes in behaviour, namely lack of concentration, inattention, withdrawn, depression and anxiety. These effects were reported during and after renovations and	Effects on memory (102) and mood swings reported by first-responders to methamphetamine drug laboratories in the US (65, 238) In general, exposures to amphetamines have been associated with neurochemical changes in areas of the brain that are associated with learning, potentially affecting cognitive function, behaviour, motor activity and changes in avoidance responses (106); physiological and behavioural/ developmental effects that include psychosis, violent behaviour, depression, irritability, hallucinations, mood swings, paranoia and sleep disorders (75, 106, 241). Limited studies on effects of methamphetamine in adolescents (242) indicates increased levels of depression, anxiety and risky sexual behaviours, with animal studies indicating impaired cognitive function (130) Children removed from homes where methamphetamine has been manufactured where the behavioural issues reported include academic difficulties (12),

Reported health effects	Cooks – based on interview data (refer to Section 5)	Cooks and others – based on observations from Police (refer to Section 6)	Police and forensic investigators – based on interview data (refer to Section 6)	Residents living in un-remediated methamphetamine-affected properties (refer to Section 8)	Published Studies
				remediation and continue to persist years after exposure. A regular visitor to the home during renovation activities reported extreme lethargy CS04: all participants reported trouble sleeping in the home. The behaviour of the young children in the home were noted to be more irritable and aggressive while living in the home CS05: trouble sleeping, fatigue, irritability, moodiness and depression. The child also displayed erratic changes in behaviour that included swings from aggression and confrontational behaviour to depression	developmental delay (78), a higher incidence and risk of externalising (acting out) problems (112-116), aggressive behaviour (112-116), post-traumatic or dissociative symptoms (114, 115) and internalising (depression, anxiety and somatisation) problems (115). Many of these studies are confounded by other issues such as criminality (including drug use), neglect and abuse (69, 71, 73)
Other health issues	None reported	Children from drug labs observed to have poor personal hygiene	None reported	CS01: other effects reported include dizziness reported by an adult following use of blower in contaminated shed CS03: other health effects reported during renovations in the home include headaches and dizziness CS05: headache Note that the participants in CS05 were former drug users who described the health effects experienced while living in the home as similar to methamphetamine withdrawal but continual	Children removed from methamphetamine drug laboratories often also associated with poor nutrition, unsanitary conditions and other medical problems (12, 69) Other health effects reported by first-responders in the US include headache, central nervous system effects (including dizziness) gastrointestinal effects, chest pain/tightness and rapid heart rate (65, 68, 102, 238)
Evidence of exposure	Not available	Not available	Prior to the use of PPE, testing of urine following exposure in an active drug laboratory reported positive levels of methamphetamine and amphetamine. Where PPE is worn by officers, analysis of hair samples (refer to **Section 7**) shows no evidence of exposure to methamphetamine or amphetamine for the hair samples analysed	CS01: Hair analysis from a family living in un-remediated property for 2 years reported methamphetamine levels in all samples, with levels in the youngest 2 children similar to the lower end of the range reported in the hair of children removed from drug laboratories and low level adult drug users CS05: Hair analysis from 13 year old child detected a low level of methamphetamine	Children removed from drug laboratories and homes where amphetamines are used have reported positive detections for amphetamines in urine (37) and hair (70, 73, 197, 208, 209)

In relation to the health effects reported in this study the following can be noted:

- Health effects reported by drug cooks interviewed in this study are expected to be unreliable as most of the individuals involved were also drug users. Observations of their own health, and others around them, was likely to have been significantly affected by drug use. The information provided by drug cooks, many of whom admitted to never wearing any protective equipment (mostly to ensure they got high from the cook itself), did not suggest that exposures during the manufacture of methamphetamine resulted in significant health effects.
- Few health effects were reported by police and forensic investigators as most of the participants were working under current protocols that ensured limited exposures occurred inside drug laboratories and they wore appropriate levels of personal protective equipment when entering and processing a drug laboratory. Information from forensic investigators who have worked in methamphetamine drug laboratories for a long period of time have indicated that before these protocols and PPE requirements, health effects (primarily respiratory irritation and skin effects) occurred. More significant health effects have been reported by first-responders in the US (40, 63, 65, 68, 102, 238, 239).

Families in the reported case studies who have been exposed in a former methamphetamine drug laboratory, or home affected by methamphetamine use, have consistently reported respiratory issues and behavioural changes, particularly within children. These have been quantified in some instances and shown to be “at-risk” or “clinically significant”.

Respiratory issues identified in the case-studies included the development of asthma and breathing difficulties, sinus problems and cough. Most of the participants also reported an increased susceptibility to infections, such as cold and flu that also included respiratory problems. Some of these health issues have also been reported in children removed from methamphetamine drug laboratories (61, 100, 240), where there is the assumption that the level of exposure to methamphetamine, as well as a range of other chemicals used in manufacture, is higher. Most of the participants reported that the respiratory problems only occurred while living in the contaminated home, however there are some respiratory effects, principally exacerbation of asthma in one participant who was susceptible to asthma prior to exposure, that have persisted after exposure in the contaminated home.

All of the case study participants have reported behavioural changes associated with exposures in former methamphetamine affected properties. The behavioural issues reported in these case studies are consistent with many of those reported in children removed from methamphetamine drug laboratories (112-116), where there is the assumption that the level of exposure is higher. More specifically these common behavioural issues include internalising (depression, anxiety and

somatisation) problems, externalising (acting out) problems and aggressive behaviour (112-116). However unlike the behavioural issues reported in children removed from methamphetamine drug laboratories, the effects reported in these case studies are not confounded by other risk factors associated with drug use, criminal behaviour, abuse and neglect. Another common behavioural issue reported by case study participants was the change in sleep patterns, in particular trouble sleeping. A lack of sleep or significant changes in sleep patterns can also result in changes in behaviour (in particular depression, anxiety and mood disorders) and a lack of concentration (243).

Other effects commonly reported by families exposed in former methamphetamine drug laboratories include skin rashes, sore and watering eyes (potentially associated with respiratory problems and increased susceptibility to infections), headaches and dizziness (i.e. CNS effects).

Participants in case study CS05 were former drug users who did not use methamphetamine immediately prior to, during or after living in the contaminated home. These participants reported the health effects experienced while living in the home were similar to withdrawal from methamphetamine, but continual. Withdrawal from methamphetamine has been associated with insomnia or hypersomnia, lethargy, exhaustion, variable appetite, vivid dreams, red/itching eyes and behavioural changes including dysphoria, depression and anhedonia, poor concentration, agitation, irritability and impaired social functioning (244, 245). Symptoms associated with methamphetamine withdrawal, in particular mood disturbance, have been reported to last for up to a year (244).

The data collected in this study does not allow for the determination of a causal relationship between exposures in former methamphetamine drug laboratories and the adverse health effects reported. However the data presented in this study provides evidence of an association between exposures at different levels and reported adverse effects. The adverse effects reported in this study are consistent with those in the literature associated with methamphetamine use, but particularly withdrawal, and manufacture.

9.5 Characterisation and Review of Potential Exposures

The data on health effects and exposure (based on contamination levels in homes and levels of methamphetamine in hair from individuals living in these homes) collected in this study are derived from opportunistic case studies. As such the amount of data where there is co-located information on the level of methamphetamine contamination on surfaces, reported health effects and measured levels of methamphetamine in hair from exposed individuals is limited.

In addition it is noted that there are a range of factors that are expected to affect the level of methamphetamine in hair, resulting in inter-individual variability (192). However hair analysis data does provide a useful tool in rank-ordering doses (192). There are two studies available where a

positive dose-hair concentration relationship has been demonstrated, one conducted with methamphetamine drug users, Han et al. (205), and the other a controlled human study, Polettini et al. (200).

It is not considered that there is sufficient data, nor are the studies available comprehensive and sufficiently robust, to enable the calculation of an actual dose to which the participants in this study may have been exposed based on the hair analysis results. However, some general calculations have been undertaken to provide an estimate of a potential range of methamphetamine doses or exposures that may have occurred in CS01.

Given that health effects have been reported in all of the case studies included in this study, in situations where the methamphetamine surface residue levels exceed the residential guideline by 3 to 52 fold, some further review of the potential methamphetamine dose or exposure that may have occurred in the case studies, and how these compare with the assumptions adopted in the development of the methamphetamine surface residue guideline (13) is relevant.

Calculations of potential exposure or dose from exposure to contamination have been undertaken separately on the basis of the available published dose-hair concentration studies available. These calculations are not considered to provide a precise characterisation of intakes/dose, due to limitations with the published dose-hair concentration studies available. However, the calculations are presented to provide a general order of magnitude indication of potential intake/dose.

The outcome of these calculations have then been combined to enable a discussion/comparison of potential exposures that may have occurred in the case study with key aspects considered in the development of the methamphetamine surface residue guideline.

Calculations from Publication 1

The study conducted by Han et al. (205) involved chronic methamphetamine drug users where methamphetamine concentrations were reported from the analysis of 1cm segments of hair, along with self-reported methamphetamine doses taken during the period of exposure for each segment (based on the assumption of 1cm growth/month). While the number of participants involved in the study was limited, it showed that methamphetamine and amphetamine in hair were well correlated with the cumulative methamphetamine dose as calculated from the daily dose of methamphetamine and the duration/time of intake. The study concluded that the correlation of self-reported methamphetamine use and hair testing can be used as a general guide in estimating dose. The study identified that a daily dose of 0.5 to 1 g of methamphetamine smoked, is required to produce detectable levels of methamphetamine (>0.1 ng/mg) and amphetamine (>0.125 ng/mg) in hair.

In CS01, hair analysis of the youngest children reported methamphetamine levels in hair at levels in excess of the detection level of 0.1 ng/mg (with 0.33 and 0.46 ng/mg reported). If the information were used from the study by Han et al. (205) levels of methamphetamine in hair >0.1 ng/mg occur with the smoking of 0.5 to 1 g methamphetamine each day. For this calculation it has been assumed that the younger children have been exposed to levels of methamphetamine similar to the dose required to result in the detection of methamphetamine in hair at levels >0.1 ng/mg.

When dealing with environmental exposures, doses are considered as mass per unit body weight per day. The body weight of participants in the study by Han et al. were not included, however if it is assumed that the adult participants had an average body weight of 78 kg (average adult body weight in Australia (246)). If the lower end of the range was considered, 0.5 g methamphetamine smoked daily, this equates to 0.0064 g methamphetamine smoked/kg/day. Studies on the bioavailability of methamphetamine indicate that a delivered dose is approximately 37% of the absolute (pipe) smoked dose (169). This would then equate to an exposure dose of 0.0024 g/kg/day, or 2.4 mg/kg/day methamphetamine.

Calculations from Publication 2

The study conducted by Polettini et al. (200) involved participants with former stimulant drug use taking controlled doses of sustained release A-(+)-MA HCl (oral administration) and the measurement of methamphetamine and amphetamine in hair. The controlled doses were administered at 2 different levels (4 x 10 mg doses [taken daily] and 4 x 20m doses [taken daily]) and the resultant hair concentrations were reported. While inter-individual variability was observed, and related to melanin concentrations in hair, the study showed dose-related concentrations in hair within each participant.

At the lowest methamphetamine dose the C_{max} concentrations reported in hair ranged from 0.6 to 3.5 ng/mg, with all hair tests reporting levels >0.2 ng/mg in the first week after the applied dose. The lower end of the range reported in the study by Polettini et al. (0.6 ng/mg, resulting from exposure to the lowest dose) was similar to the levels reported in the youngest children in CS01. The lowest daily dose of 10 mg methamphetamine (as the doses were taken daily for 4 days) in the study by Polettini et al. resulted in an average intake of 0.1 mg/kg/day methamphetamine (body weight data was provided in the study) assuming approximately 70% bioavailability via oral administration (178).

Potential Intakes of Methamphetamine from Environmental Exposure

Based on the general calculations presented above, to obtain methamphetamine levels in hair are levels similar to those reported in the youngest children in CS01, the intake of methamphetamine may be in the order of 0.1 to 2.4 mg/kg/day. These intakes are similar to those that may be associated with the therapeutic dose of methamphetamine commonly prescribed in ADHD medications, where a prescribed dose of 5 to 25 mg/day results in a dose of 0.23 to 1.15 mg/kg/day for a child (156).

In relation to defining the level of methamphetamine contamination that may be present in an individual property it is more typical to compare environmental contamination data, such as surface residues tests, to a guideline. For methamphetamine in a residential home a guideline of 0.5 μg/100 cm^2 has been derived (13) based on intakes by young children (via ingestion and dermal absorption of methamphetamine) that equals the relevant acceptable daily intake of 0.0003 mg/kg/day (3, 152).

Intakes of 0.1 to 2.4 mg/kg/day are 330 to 8000 times higher than the acceptable intake. Hence it would be expected that if the assumptions adopted in the development of the surface residue guidelines are correct, the methamphetamine surface residue levels in the home should be around 330 to 8000 times higher than the guideline.

For CS01 this is not the case. Limited environmental sampling was undertaken in the home where the methamphetamine surface residue levels reported ranged from 11.7 to 26 μg/100 cm^2, approximately 23 to 52 times higher than the guideline. In this case study elevated levels of methamphetamine were reported in the hair of the two youngest children, both boys, who are known to play on the floor together, run through the house with their hands on walls and not wash their hands often. Their exposures are likely to have occurred throughout the home.

This calculation, while general in nature, suggests that actual intakes of methamphetamine that occur inside a home that has not been remediated may be significantly greater than calculated using the assumptions and approach adopted in the derivation of the remediation guidelines. Higher levels of intake would better explain the occurrence of health issues reported in all the case studies considered in this study in homes where methamphetamine surface residues were reported to only exceed the guideline up to 52 times. This suggests that either:

- The dose-response studies available for methamphetamine in hair overestimate the likely dose. It is noted that dose-response studies available in relation to methamphetamine are limited and hence evaluations using these data are considered to provide a general indication of exposure only;
- The methods used to sample and quantify methamphetamine on surfaces underestimates the level of contamination to which people are exposed. The sampling of residues on

surfaces inside homes involves the collection of a sample over a 100 cm^2 area per sample. In many cases only one sample is collected in each room, or only a small number from a whole home. These samples are then assumed to be representative of contamination on all surfaces in the home. However, residue levels are expected to vary throughout a home across a range of different surfaces. Use of this data, therefore has limitations in relation to characterising actual levels to which individuals are exposed. Recoveries of methamphetamine residues from surfaces using wipe sampling techniques have been reported to be less than 100% (51, 168), with specific studies indicating variability between 15% for porous surfaces and 80% for smoother surfaces (161). The variability of analytical results between laboratories has been found to range from 3-30% (168) to 1-50% (51). Hence depending on the surface types present in a home the sampling and analysis of methamphetamine residues may underestimate actual contamination levels;

- The application of the remediation guideline for assessing the risks posed by former clandestine drug laboratories that have not been remediated is not appropriate. The remediation guidelines are developed using exposure assumptions based on the completion of remediation, where methamphetamine is no longer present, and cannot be remobilised, in indoor air. These assumptions may result in an underestimation of exposures that occur in properties where remediation has not occurred. Preliminary assessment of potential exposures that may occur where methamphetamine is present in indoor air, via inhalation, absorption to materials and oral intakes and dermal absorption (58, 155, 156), suggest that these exposures may be significant. These exposures may occur where remediation has not been undertaken or is not effective. As a result it may not be appropriate to use remediation guidelines for the assessment of whether a contaminated property has the potential to pose a risk of harm to future occupants; and/or
- Some of the assumptions adopted for the characterisation of intake from exposure pathways inside the home are not well enough understood and may be underestimating actual exposure. Some additional studies have been undertaken to better understand the fate and transport of methamphetamine inside a home and potential intakes that may occur during exposure. For example recent studies are available that are aimed at better defining dermal absorption and dermal transfer efficiencies (46, 54, 154) for methamphetamine from surfaces inside homes. These data suggest there is the potential that dermal absorption of methamphetamine is more variable (depending on different surface types), and the proportion of methamphetamine transferred from surfaces to skin is higher, than assumed in the development of existing guidelines. If an average (from dry and wet hands) dermal transfer factor were used in the equations adopted for the derivation of the guideline (with all other assumptions unchanged) the residential surface guideline for methamphetamine would be 0.2 μg/100 cm^2, lower than the current guideline. Further research is required to better understand and define these parameters.

Further research is required to better understand these issues and the potential for methamphetamine intake, particularly in younger children where the potential intake of methamphetamine from environmental contamination has been shown to be significantly higher than for older children and adults. There are a range of uncertainties identified in this review that relate to characterising contamination levels and how individuals may be exposed to the contamination that remains in homes. Understanding these uncertainties and better defining exposures, in particular unwitting exposures that may occur during regular contact with surfaces as well as inhalation is needed.

In addition further work may be required to refine/revise the guidelines to ensure they are adequately protective of all situations. This includes considering a home that is not remediated, more specifically addressing the questions:

- Does the home require remediation?
- When has remediation been completed to a safe level?

In addition the remediation levels and methods need to adequately address and protect future occupants involved in and following future renovation activities.

10.0 DOMESTIC PROPERTY EVALUATION

10.1 Risk Based Approach to Assist in Remediation of Former Clandestine Drug Labs

10.1.1 Purpose of Developing Evaluation Technique

The level of risk posed by contamination that may remain at a former clandestine drug laboratory to the health of future occupants needs to be understood to inform the remediation of the premises. In Western Australia a simple tiered system has been established where Police/Forensic Scientists attending the property provide an initial assessment of risk based on information available. **Section 6.3** provides further detail in relation to the assessment approach undertaken, however in summary the approach relies on the expertise of forensic investigators at the site who have key information and observations on the likely method of manufacture, the size and the manufacturing operation and where the manufacture and chemical storages occurred (which are key factors in the level of risk posed by a former drug laboratory). Based on this evaluation the property is categorised as either:

- Tier 1/low risk, where a simple clean-up can be undertaken; or
- Tier 2/high risk, requiring detailed assessment and remediation.

Other states in Australia do not have a similar method. Hence when police notify local Councils of the presence of a former clandestine drug laboratory the level of risk is assumed to be the same in all premises. In addition the information/observations used by forensic investigators in Western Australia is often not provided to Councils (and others) to be considered in evaluating the level of risk. While local Councils have the responsibility to ensure remediation occurs and that the premises are not deemed to be habitable until remediation has been completed, it is the property owners, or the relevant government housing department, who are required to comply with Council directives typically by issuing legal notices and are financially liable for the cost of the remediation.

Where the risk of harm posed by these properties is assumed to be the same for all premises this can result in either: higher levels of remediation costs than may be necessary; or no, or insufficient, remediation being undertaken at all to avoid perceived high levels of cost. In addition the importance of remediating former clandestine drug laboratories is not well understood by local Councils, who currently have the responsibility of ensuring remediation is undertaken. There are situations such as the case studies outlined in **Section 8** where Councils have not enforced appropriate levels of assessment and remediation, and/or have not prevented habitation in the home prior to the completion of remediation. The case studies outlined in **Section 8** highlight the risks posed to public health if these properties are not appropriately assessed and remediated.

An evaluation of the features of a home that are conducive to the spread of residual contamination in a property used for the manufacture of methamphetamine was undertaken as an honours project at Flinders University (247). The work involved evaluating the spread of methamphetamine residues in six Housing SA properties in South Australia to determine design and features of a home that may be conducive to the spread of contamination in a property. This study identified and confirmed a range of factors that can be considered when inspecting a property that may assist in determining the level and spread of contamination in the property. Specifically the study confirmed the level of risk needs to be assessed for each individual property as there are a number of factors that affect the level and spread of contamination. To enable a preliminary assessment of the level and spread of contamination the study recommended that to enable a preliminary evaluation of risk to be undertaken the use of preliminary immune-assay swab tests to assess residue levels and a ppbRAE air sampler to test for VOCs in air.

This study has been further built on with data and observations obtained and presented in this research (247) to enable the development of a risk assessment checklist that can be used at individual properties to determine the level of risk, that is defined based on both the level of contamination and the spread of contamination, posed by a property. Such a checklist can then be used to inform early remediation steps and the development of more detailed assessments and remediation.

10.1.2 Characteristics Relevant to Risk Ranking

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 (16).
- Use of methamphetamine in the premises (particularly smoking) (247). This aspect has not been included in the risk matrix, as the focus of the assessment relates to former clandestine drug laboratories. Risks to health posed by these properties should be appropriately assessed and remediated.
- Closing up the home to prevent detection (confirmed by information/observations from cooks and Police). 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

(151, 158, 247), 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 (confirmed by information/observations from cooks and Police and residue data from former drug laboratories).
- Use of ventilation systems inside the home (confirmed by cooks as a common method for removing gases during the cook, observed by Police and from assessment and residue data from former drug laboratories) consistent with published data (58).
- Fire and explosion (confirmed from assessment and residue data from former drug laboratories) and consistent with data from premises evaluated in the US (47).
- Observation of burns, stains and powder residues (confirmed from assessment and residue data from former drug laboratories), likely to reflect that little care was taken during the cook, which may have resulted in the spread of contamination.

In relation to preliminary indicators of the presence of contamination the following have been identified:

- Preliminary/screening testing for methamphetamine residues using an immune-assay test (targeted at the likely location of manufacture) provided a confirmation of the presence (and in some cases) spread of contamination (confirmed from assessment and residue data from former drug laboratories). This is identified as a key preliminary assessment technique in another study (247).
- Elevated levels of total VOCs as reported using a PID were associated with elevated levels of contamination in the property (confirmed from assessment and residue data from former drug laboratories). This is identified as a key preliminary assessment technique in another study (247).
- pH levels indicative of the presence or use of acids and alkalis (confirmed from assessment and residue data from former drug laboratories) – 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.

The above characteristics can be used in the development of a preliminary risk assessment tool that can be used 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. The risk scoring system developed is outlined below.

The risk scoring system (risk matrix) is intended to be used as a tool to assist in understanding the potential risk posed by a property formerly used as a clandestine drug laboratory. It is not intended to be used as a tool to screen properties that have not been identified as former clandestine drug

laboratories, or properties that may be contaminated from the smoking of methamphetamine. For these other properties, the key indicator of contamination remains the use of surface contamination testing, using either an immunoassay test or the collection of a surface wipe sample for laboratory analysis. Where such a test indicates the presence of contamination above the relevant guideline, further assessment and remediation should be undertaken as outlined in the Australian guidelines (13).

10.2 Risk Scoring Scheme (Risk Matrix)

The risk scoring system/risk matrix developed enables a score to be calculated based on information that may be obtained from the Police report and/or a preliminary site inspection. The matrix is designed to be filled in (potentially) by housing officers from state housing authorities and individuals undertaken a preliminary site inspection (that may include Environmental Health Officers [EHOs] or consultants engaged by EHOs). It is recognised that not all jurisdictions provide sufficient information in the Police report use in the risk matrix. Hence the matrix has been designed to enable a risk ranking to be determined with and without a Police report, and with a limited Police report.

Any preliminary investigation should be undertaken with appropriate PPE. The level of PPE required for entry into the property may be indicated on the Police report. However, if there is no information provided the PPE worn should include enclosed shoes/boots, long pants, long sleeved short and gloves. Indoor areas should be ventilated (doors and windows opened) as part of the preliminary investigation.

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 cm^2 for residential homes (13), and the potential for the contamination to be spread throughout the premises. The risk matrix includes categories of “moderate” and “high” that enable some distinction between premises with high levels of contamination that is not widespread and contamination, either just above the guideline or at a high level, to be widespread. The remediation approach to both moderate and high category premises is expected to be the same, and the use of the risk matrix may not fully distinguish between these categories, particularly where information and observations are limited. Hence for practical purposes it is of benefit to consider a combined moderate/high level category as indicative of where more intensive investigation and remediation is required.

The risk levels in the risk matrix are defined as:

Table 31 Definition of Risk Categories Adopted

A Low	This category relates to premises with a low level of contamination (potentially below, at or just above 0.5 µg/100 cm^2) that has not spread throughout premises (i.e. confined to small area)	For these premises the level of remediation required will be limited
B Moderate	This category relates to premises where there is the potential for high level contamination (well in excess of 0.5 µg/100 cm^2) that may not be widespread; and premises where there is the potential for contamination (likely in excess of 0.5 µg/100 cm^2) to be widespread	For these premises the level of assessment and remediation will be more involved and site-specific. The remediation will require validation to demonstrate that the premises have been adequately cleaned and is suitable for use
C High	This category relates to premises where there is the potential for high level contamination (well in excess of 0.5 µg/100 cm^2) that is widespread	

The risk matrix is split into 4 key steps. The matrix can be filled in manually, and the scores manually added to obtain the final score, or electronically where the score is automatically calculated. The steps are outlined as follows, as is provided in the information sheet that accompanies the risk matrix:

Step A:

This is used to indicate if a Police report is available and can be used for the preliminary assessment. Where there is no Police report a score is allocated (as the lack of this information is a risk factor for the premises), then skip to **Step C**. If you have the Police report, complete **Step B** based on information from the Police report.

Step B:

This contains 4 questions that relate to information that may (or may not be) provided in the Police report. Do not complete if you don't have the Police report – move on to **Step C**.

B1 Drug manufactured in premises – this may be clearly stated on the Police report or may be inferred from the presence of chemicals specifically associated with the manufacture of methamphetamine. If it is not clear or you are not comfortable knowing what drugs were manufactured, select "not known".

B2 The Police report may provide a hazard ranking for people re-entering the premise (once they have completed their investigation), based on the hazards they identified and the potential for these to be of concern to others entering the property. If there is no hazard ranking provided then select the middle category (score of 3).

B3 This relates to the chemicals that were identified on the premises by the Police. The level of risk allocated is based on the manufacture methods likely to be present based on the chemicals identified.

B4 The size and scale of the lab is an important risk factor for contamination. The manufacture of small quantities of drugs, infrequently, typically for personal use has a lower risk than premises where larger quantities of drugs are manufactured or drugs are regularly manufactured for a long period of time. Sometimes this information is not available on the Police report. It may be obtained by discussing the property with the Police contact listed on the report.

Step C:

This step relates to observations and preliminary tests that may be conducted during the preliminary site investigation.

Observations:

C1 If yellow/brown iodine staining is evident within the premises, this indicates that a higher risk manufacture method was likely within the premises. This may be observed on benches, windows, walls, ceilings, ventilation fans and air conditioner filters.

C2 Evidence of spills, burns and powder residues suggests that little care was taken with the manufacture and it is likely that contamination has spread within the premises. These are typically evident on benches (kitchen or bathroom benches) and floors.

C3 If the premises are very messy/unhygienic it suggests that little care was taken with the manufacture and it is likely that there has not been any cleaning. There is the potential for contamination to be present and it may have spread within the premises.

C4 If a premises has ducted air conditioning (fully ducted or a split system that results in mechanical movement of air between rooms) there is a greater chance that contamination has spread within the premises.

C5 If a premises has roof space ventilation fans particularly in areas where manufacture was likely, such as the bathroom and kitchen (noting that a number of range-hoods vent into the ceiling space) then there is the potential for contamination to have spread within the premises (via the roof space).

Preliminary tests – these are not always undertaken but where they are conducted they provide useful information for the purpose of ranking the contamination risk. If the tests are not undertaken there is a score that can be selected for ‘not undertaken’.

C6 The conduct of a surface residue test using an immunoassay test (with a detection limit of 100-500 ng), targeting the area of known/suspected manufacture provides direct feedback

on the presence of residues at levels higher than health based criteria. If the location of manufacture is not known/suspected, it is recommended that a sample is collected from the wall above the stove hot plates and/or in the bathroom as these are common manufacture locations. It is noted that a positive result for this test confirms the presence of contamination that should be further evaluated through additional testing in accordance with the Australian guidelines (13).

C7 A pH test from stains in areas of known/suspected manufacture provides a direct indication of the presence of acids and/or alkalis that have the potential to be a hazard for future occupiers. The spilling of chemicals suggests little care was taken in the manufacture and potential for contamination.

C8 A test for VOCs in air within the premises can be undertaken using a handheld instrument (such as a PID). The detection of levels above 1ppm (or above ambient/background PID levels) indicates that volatiles remain in air in the home from the manufacture (even after Police operations are completed). This is an indicator that significant quantities of solvents were used, suggesting a large scale manufacture is more likely. It is noted that a PID provides a general measure of volatile chemicals in the air and will also detect volatile chemicals from recent painting and repair work or cleaning products. The results from a PID should be considered in the context of other observations within the individual property (such as evidence of new painting, repairs or cleaning).

Steps A-C provide the risk score for the inside of the premises and risk ranking as low, medium or high.

Step D:

This step is included to identify those premises where additional work may be required to address contamination that may be within a septic waste system (from the dumping/washing of chemicals and waste down the sewer, where a septic system is present), drinking water tank or in outdoor areas. The dumping of chemicals and waste down drains on the property may have damaged fixtures and fittings – these should be checked and replaced as part of the remediation.

For the outdoor areas there is the potential for soil to be contaminated from the dumping (or burning) of chemicals and waste.

Evidence of dumping includes the presence of chemical or other containers likely to have had drug waste, stained soil (potentially white, red or yellow powder residues evident), patches where grass/plants no longer grow (bare patches) and burn pits.

If the premises is located near a surface water body (creek, dam etc.) then inspect for evidence of chemical/waste disposal into the water body.

Step D does not change the risk ranking, however where yes is indicated for questions D1, D2 or D3 additional tests and remediation of these areas may be required.

The following presents the risk matrix developed.

The risk matrix is developed such that it can be used manually or as a spreadsheet that sums up the risk score automatically.

Risk Matrix - Clandestine Drug Lab - Ranking of Indoor Contamination Risk Based on Preliminary Information and Inspection

Issue/Aspect		Value for Selection (select one score for each group/question)	
Step A	**Do you have a copy of the police report for the property?**	0	yes - go to Step B
		15	no - go to Step C
	Score A		**Allocated score**

Step B	**Risk Ranking from Police Information - Do not complete if the Police Report is not available**	
Drug manufactured (can select more than 1 if relevant for a site)	2	Methamphetamine - note this matrix is more specifically relevant to the manufacture of methamphetamine but can cater for others that may be manufactured
	5	MDMA
	5	MDA
	5	Pseudoephedrine
	5	Other
	5	Not known
		Allocated score
Hazard ranking (provided by Police)	5	chemical resistant overalls recommended
	3	safety glasses, gloves and/or dust mask recommended
	2	no requirements
		Allocated score
Chemicals reported in premises (in addition to pseudoephedrine, ephedrine and common solvents - used in all methods)	6	P2P, methylamine, mercury salt, benzaldehyde
	6	hypophosphorous acid, iodine, hydroiodic acid, acetone, sodium hydroxide, red phosphorous
	3	lithium, sodium, ammonia (anhydrous)
	3	acid/alkaline wastes only
	4	other chemicals (safrole, isosafrole, benzaldehyde, L-phenylacetylcarbinol, dichloromethane, chloroform, formic acid)
	3	equipment only, no chemicals, inactive lab reported
		Allocated score
Size of lab (if reported)	5	large amounts of chemicals, drugs or wastes reported
	3	small amounts of chemicals, drugs or wastes reported - consistent with user cooking for personal use
	5	no information available on lab size
		Allocated score
Score B	-	Total for Step B

Step C	Risk Ranking from Site Inspection (know premises was used for manufacture)	
Evidence of yellow/brown iodine staining	5	yes
	2	no
		Allocated score
Evidence of burns, scorch marks, acid/alkali burns, powder residues on surfaces	5	yes
	2	no
		Allocated score
Premises has air ducted air conditioning (or ventilation room to room)	5	yes
	2	no
		Allocated score
Premises has roof space ventilation fans (particularly in area of cook)	4	yes
	2	no
		Allocated score
Premises is very untidy/messy/not cleaned	4	yes
	2	no
		Allocated score
Preliminary immunoassay analysis for methamphetamine residues from location where manufacture suspected/known (preliminary test - detection limit of 100-500 ng)	10	positive
	1	negative
	10	not undertaken
		Allocated score
Preliminary test for pH from location (s) where manufacture suspected/known or stains	5	<5 or >8
	1	between 5 and 8
	1	not relevant (no stains and no evidence of cooking)
	5	not undertaken and potential for acids/alkalis to be present
		Allocated score
Preliminary screen for VOCs using PID	5	>1ppm
	1	<1ppm
	5	not undertaken
		Allocated score
Score C		Total for Step C

Total score: A+B+C	**0**
Risk Ranking	

Step D	Waste Issues	
Is septic system present for premises	**Yes**	**need to test and potentially clean septic system**
	No	if internal drains damaged by waste disposal - require repair/replacement
Is there evidence/suspicion of waste disposal to soil or other areas (surface water)	**Yes**	**needs to be tested and evaluated**
	No	

Risk Ranking	Description	Total Score
LOW (low level risk to public health)	Low level contamination, not likely to have spread throughout premises	<36
MODERATE	Contamination present (may be high levels), may not be widespread throughout premises but testing should be done to evaluate contamination levels and spread in property	<45
HIGH	Potential for high levels to be present and wide-spread throughout premises	>45

Contamination considered to be moderate to high where present at levels above 0.5 μg/100cm^2 on surfaces

10.3 Testing of Risk Scoring Scheme

10.3.1 Testing with Remediation Data

The risk matrix has been tested with information provided in the assessment and remediation reported for 50 of the 100 former clandestine drug laboratories evaluated in this study, as summarised in **Section 6**. For the data set evaluated in relation to contamination, the risk matrix was tested using only information provided by Police, on the property characteristics or in preliminary testing (if conducted). The measured level and spread of methamphetamine contamination in the property was not considered when testing the risk matrix. Once a risk ranking of low, medium or high was determined the contamination data was then reviewed to determine whether the risk matrix correlated with the measured data in relation to the level and spread of contamination.

It is noted that not all of the properties for which contamination data has been included in this study provided sufficient information on the property (or from Police) to enable the risk matrix to be used. Hence testing of the risk matrix was limited to those properties where sufficient information was available on the property (or from Police).

Table 32 presents a summary of the testing undertaken using the risk matrix on information/data available from the contamination/remediation data.

Table 32 Outcomes of Testing Risk Matric with Contamination/Remediation Data

Site ID	Risk Ranking (from Risk Matrix)	Maximum Level of Methamphetamine Residues Reported in Property (µg/100 cm^2)	Spread of Contamination in Property	Correlation between Risk Ranking and Property Data
NSWH01	moderate	3	Wide-spread	✓
NSWU02	moderate	3	Wide-spread	✓
NSWH03	high	2450	Wide-spread	✓
NSWH04	low	0.29	Localised	✓
NSWH05	high	269	Wide-spread	✓
VICH06	high	77.3	Wide-spread	✓
VICH07	high	179	Wide-spread	✓
QLDH08	moderate	2.1	Wide-spread	✓
QLDU09	moderate	0.45	Wide-spread	✓ risk ranking more conservative
VICU10	high	12.6	Some spread	✓
VICH11	high	1.82	Wide-spread	✓
VICH12	high	24.43	Wide-spread	✓
VICH13	moderate	9.1	Some spread	✓

Site ID	Risk Ranking (from Risk Matrix)	Maximum Level of Methamphetamine Residues Reported in Property (µg/100 cm^2)	Spread of Contamination in Property	Correlation between Risk Ranking and Property Data
VICH14	moderate	0.402	Some spread	✓ risk ranking more conservative
VICH15	moderate	18.2	Some spread	✓
VICH16	high	179	Wide-spread	✓
VICH17	high	28.7	Wide-spread	✓
VICU18	high	45.5	Wide-spread	✓
VICU19	moderate	1.6	Wide-spread	✓
QLDH20	moderate	8.9	Wide-spread	✓
VICH21	moderate	1.87	Some spread	✓
VICH22	high	89.3	Wide-spread	✓
VICH23	high	320	Wide-spread	✓
VICU24	high	406	Wide-spread	✓
VICU25	high	3.1	Wide-spread	✓
NSWU26	high	15	Wide-spread	✓
NSWH27	high	910	Wide-spread	✓
NSWU28	high	15	Wide-spread	✓
NSWH29	high	73	Some spread	✓
NSWH30	high	>0.5	Insufficient data to determine spread	✓
NSWH31	moderate	0.25	Wide-spread	✓ risk ranking more conservative
NSWH32	low	1.4	Insufficient data to determine spread	✓
NSWH33	high	46	Wide-spread	✓
NSWH34	high	33	Wide-spread	✓
NSWH35	high	>0.5	Wide-spread	✓
NSWH36	high	>0.5	Wide-spread	✓
NSWH37	moderate	>0.5	localised	✓
NSWH38	moderate	>0.5	Insufficient data to determine spread	✓
NSWH39	moderate	11.4	Wide-spread	✓
NSWH40	moderate	1400	Wide-spread	should be high risk
NSWH41	high	490	Wide-spread	✓
NSWH42	low	<0.05	Insufficient data to determine spread	✓
NSWH43	moderate	>0.5	Wide-spread	✓
NSWU44	high	130	Wide-spread	✓
WAH45	high	115	Wide-spread	✓
WAH46	moderate	12.1	Wide-spread	✓
WAH47	moderate	2	Wide-spread	✓
VICH98	high	64.7	Wide-spread	✓
SAH99	moderate	0.5	Some spread	✓
SAU101	low	<0.5	Insufficient data to determine spread	✓

Based on the test results, where the risk rankings of moderate to high are grouped together the risk matrix identified all of these properties. In some cases the risk matrix provided a more conservative risk ranking, placing some properties that may be considered a low risk into the moderate risk category. Where a property was clearly ranked as low risk the risk matrix identified these properties.

It is important that properties that are ranked as medium to high risk are those that are assessed in more detail prior to remediation works being undertaken. This is consistent with the definitions provided in relation to the risk ranking levels.

10.3.2 Field Testing

Limited field testing of the risk matrix was undertaken, primarily due to the limited number of clandestine drug laboratories identified in jurisdictions (in particular South Australia) where there is the opportunity for housing officers to undertake a preliminary assessment. Only 2 properties were identified in the period of assessment within Housing SA where the housing officer was willing to test the risk matrix.

In both cases the housing officer calculated a risk ranking that was the same as the researcher, both of which correlated with the subsequent contamination test results.

10.4 Application of Risk Based approach

Information obtained during this research project have been used to assist in the development of the "*NSW Guidelines for the Assessment and Management of Premises used for Clandestine Drug Laboratories and Hydroponic Drug Plantations*" (248). These guidelines have been developed with NSW Health to provide more specific guidance in NSW on the assessment and remediation of clandestine drug laboratories and links with (and follows) the national guidance (13).

The NSW Guidelines include a more simple approach to determining a high or low risk property, based on information assumed to be available from NSW Police. The timing for guideline development did not enable the inclusion of the more detailed checklist developed in this study. However the checklist can be used in conjunction with the NSW Guidelines (or any other guidelines) as part of the preliminary assessment.

In NSW, when the Local Council is notified by NSW Police of the presence of a former clandestine drug laboratory or hydroponic plantation, NSW Police provide notification and advice to the property owner that these activities have occurred and assessment and remediation is required prior to further occupancy.

Outside of providing advice to homeowners in relation to the actions that need to be undertaken to assess and remediate the property, the current legislative framework provides for the issue of Orders or Notices by Councils under the following:

- An Order under Section 124 of the *Local Government Act* – where the contamination was located within a residential building.
- A Notice under the provisions of Section 91 of the *Protection of the Environment Operations Act (POEO Act)* – where the contamination was located outside a building on land, drains, pathways etc.

After the laboratory has been dismantled and any bulk chemicals and equipment is removed a sticker is placed on the door of the property by NSW Police which indicates that occupancy should not occur until site remediation has been undertaken by a suitably qualified contractor to the satisfaction of the local Council. This sticker provides advice to owners and occupants of the premises only.

The information provided by NSW Police on clandestine drug laboratories is very limited and does not provide sufficient information to enable the level of risk (for future habitation) to be determined. As a result all clandestine drug laboratories reported in NSW are perceived as a high risk and require detailed assessment and remediation. This results in a significant cost to owners. In addition the high costs adds to issues perceived by Councils in relation to their legal powers to require assessment and remediation. In particular some Councils do not want to be in a position where they have to do the assessment and remediation (where owners are non-compliant with Notices or Orders) as NSW legislation makes it difficult to recover costs from the owners.

Access to the use of the risk matrix for preliminary assessment provides a tool that can be used to better identify premises with a low level of risk (where the level and cost of assessment and remediation is lower) and those premises with medium to high level risks (where it is important that a more detailed assessment and remediation be undertaken) where the information provided by NSW Police or the Council is limited.

The outcomes from this research recommends that application and use of the risk matrix in all State jurisdictions in Australia can provide a useful tool for the preliminary assessment and ranking of risk at a property. The risk matrix can also be utilised within international jurisdictions to enable preliminary ranking of risk to be undertaken and considered in the context of local/regional guidance on the assessment and remediation of former clandestine drug laboratories.

11.0 LIMITATIONS AND FURTHER RESEARCH

11.1 Limitations of the study

This study has presented and evaluated information and data from a range of sources. There are a number of limitations associated with the information and data presented that should be considered when further reviewing or utilising this data:

- The manufacture of methamphetamine is an illegal activity and hence obtaining access to individuals and premises affected by the manufacture is difficult and limits the data that can be obtained under informed consent for research purposes.
- It is estimated that only 1 in 10 clandestine drug laboratories are detected by Police. This limits the number of properties that are known and have the potential to be included in this research. It also means that there is a significant number of former properties that may be affected by contamination from a clandestine drug laboratory that are not known to Police, local Councils, homeowners, tenants or the general public.
- From the detected clandestine drug laboratories, the number of cooks who were in the prison system at the time of this research was also limited. This may be addressed through the conduct of a longer term study.
- Information obtained from individuals in prison who have been involved in the manufacture of methamphetamine is limited to individuals who provided informed consent. This mainly comprised individuals who manufactured methamphetamine for the primary purpose of personal use. It was observed that individuals who may have been involved in larger scale manufacture, and where there may be a third party involved, were not willing to participate in this study. This means the information obtained does not reflect the full range of manufacturing that may occur in the community.
- Information obtained from individuals in prisons is expected to incorporate some level of deception. Not all of the answers provided may be truthful. Some level of deception was perceived to be present in a number of the responses provided. A number of those interviewed remained concerned that their answers would result in additional charges or changes in their sentences or chances of early parole.
- Information provided by Police and forensic investigators were limited to a small number of individuals, primarily from Western Australia. This data was limited due to a number of jurisdictions not consenting to the conduct of the research or discussions indicating that open and honest observations would not be obtained. Where information was obtained the level of detail provided varied significantly between individuals, particularly between males and females, suggesting that further work needs to be done in this area.

- Analysis of hair samples from Police officers involved in active investigations in clandestine drug laboratories was limited to officers in the current West Australian drug squad. It is noted that most of the staff in the drug squad worked in this area for a period of approximately 2 years. This is a policy that has been implemented to prevent corruption. Consent was not obtained from other jurisdictions. This data only allows conclusions to be drawn in relation to potential exposures to may have occurred by officers in the West Australian Police force in a specific time period. The conclusions cannot be carried over to other jurisdictions as each state has different procedures for minimising exposures in drug laboratories including different use of PPE.
- Data obtained in relation to the level of contamination in properties from remediation companies is dependent on the sampling and analysis protocols and methods adopted by each assessor. These were found to vary significantly between assessment/remediation companies. The sample locations were selected by the assessment/remediation companies and hence there was no consistent approach adopted to the sampling and assessment of these properties. This may be addressed through the development and implementation of more prescriptive and consistent sampling guidelines in Australia.
- Information and data on exposure and health effects by individuals who have been unknowingly exposed in a former clandestine drug laboratory is based on a limited number of case studies. Due to difficulty in obtaining information on former clandestine drug laboratory locations from Police and Councils (due to privacy issues) the case studies evaluated are limited to opportunistic case studies only. This may be addressed through the conduct of a longer term study where a larger number of case studies can be included.
- The health effects reported by individuals involved in the case studies, and the information provided by parents from the BASC-2 behavioural checklist, may be subject to some level of bias. This bias may be due to a heightened sense of concern and awareness as a result of the knowledge that they were residing in a contaminated home. The use of the standardised behavioural checklist BASC-2 includes a range of questions to determine if the responses provided are valid or significantly biased. As a result, the BASC-2 scoring system enables significant bias to be identified, however less obvious bias cannot be easily detected. The self-reported health data had no specific questions that could provide a check on reporting bias.

Overall, while some limitations have been identified in relation to the study conducted, the data is sufficiently robust to demonstrate that the manufacture of methamphetamine has the potential to result in significant levels of contamination and that exposure can occur during manufacture and by police and forensic investigators where PPE is not used. If a former clandestine drug laboratory is not identified, is not remediated or is not properly remediated the data presented in this study

indicates that there is the potential for a significantly level of exposure to occur, particular for young children. Where exposure occurs there is the potential for adverse health effects to occur.

From the information obtained and observations obtained during this research it is the opinion of the researcher that there is the potential for a significant number of properties to be present within the community that are affected by some level of methamphetamine contamination. The case studies are not considered to be isolated issues, rather they are considered to be examples of potentially wider-exposure and health issues in the community from clandestine drug laboratories. The fact that approximately 1 in 10 clandestine laboratories are detected by Police, limitations identified in relation to the effective assessment and remediation of these properties and difficulties in identifying the former clandestine drug laboratories detected by Police suggest that there is the potential for a significantly greater number of homeowners, tenants and their families being inadvertently exposed to methamphetamine and other contamination in homes throughout Australia. In addition current remediation methods may not be adequately addressing the presence of contamination in the home so there is the potential for recontamination and remobilisation with renovations. This has the potential to result in further exposure and health issues in the community.

It is not considered unreasonable to compare the potential significance on the contamination issues associated with former clandestine drug laboratories with that of lead paint. The exception being that homeowners have the potential to suspect the presence of lead paint based on the age of a property, identify and remediate the issue, whereas contamination from the clandestine manufacture of ATS is likely to be unknown, and not visible.

11.2 Further research

The data collected and evaluated in this study provides an important step in understanding the behaviours of those involved in operating methamphetamine clandestine drug laboratories that result in contamination, the level of contamination that occurs as a result of the manufacture of methamphetamine inside residential homes in Australia, exposure and health issues that may occur during manufacture and by law enforcement in Australia and exposure and health issues that may occur to the public where ATS clandestine drug laboratories are not appropriately remediated.

Based on the work undertaken there are a number of issues that have been identified that require immediate follow-up and action, that include:

- Provide information and recommendations for follow-up medical and psychological assessments to case study participants. Participants involved in the case studies presented in this research have identified a range of health and behavioural issues that have likely occurred, or been identified, as a result of exposure in methamphetamine-affected

properties. Participants in this study have been provided with the results of assessments/analyses undertaken in this study. In addition, where the data obtained indicated the potential for elevated exposures, presence of health problems and/or clinically significant behavioural indicators, information has been provided for participants to seek medical follow-up and/or review and evaluation by an appropriately qualified child psychologist.

- Provide more information on the significance of exposure and potential health effects to health authorities and local Councils. It is important that these agencies understand the potential significance of the health risks to the public in the situation where remediation is either not undertaken, or not completed properly. In addition it is important that the legal mechanisms for ensuring the proper assessment and remediation of former ATS drug laboratories are clear and enforceable in all states of Australia. Where remediation has not occurred, legal mechanisms need to include provisions to provide a notification on property titles or a suitable other notice (or searchable website), that is discoverable during the sale of a home, to advise any future owner/occupier that the property was a former ATS drug laboratory and that it is unsuitable for occupancy until assessment and remediation is completed. The mechanisms need to ensure ATS contaminated properties are not sold or re-occupied by homeowners or tenants prior to assessment and remediation. This may require changes in legislation as well as further education and training.
- Raise awareness in the public of the hazards associated with ATS contamination, from both the clandestine manufacture of ATS and from smoking ATS. Both these activities can result in the presence of significant levels of contamination in a home that have the potential to affect the health of homeowners and their families. There is currently very little awareness of the potential for such contamination to be present and the health implications that are associated with such contamination.
- Determine the need to revise the current indoor surface residue guidelines for methamphetamine. The data collected in this study indicates that the current guidelines are not adequate for assessing contamination at a property. In addition the remediation guideline may not provide a sufficient margin of safety to ensure health effects are not occurring in situations where the guidelines are exceeded by a small margin, say 10 fold. These issues need to be further discussed with the relevant government authority with the aim of ensuring the guidelines used to assess and remediate clandestine drug laboratories are adequately health protective.
- Address potential exposure issues that may occur during home renovations. Current remediation guidelines do not specifically require remediation methods that ensure future home renovations do not result in recontamination of a home or the uncovering of contamination such that exposure may occur. It is important that guidelines are

implemented to ensure the remediation methods and techniques are adequately protective of these issues.

In addition, the data collected in this study has identified a number of areas where further follow-on work is required, which includes:

- Collection of further evidence of health effects in individuals exposed to contamination in ATS-affected properties to supplement the case studies included in this research. This requires the collection and evaluation of additional information both domestically and internationally to ensure there is sufficient robust evidence of exposure and health effects in individuals exposed ATS contamination in these properties.
- Conduct follow-up research on health effects observed in participants from the case studies to determine how long the observed health effects persist after exposure has stopped. While some observations have been reported in this research, there is currently no published data on how long the observed health effects and behavioural changes persist after exposures to ATS in former clandestine drug laboratories has stopped.
- Liaise with Police departments to improve the information provided to Councils in relation to former ATS clandestine drug laboratories. The information provided to Councils by Police in relation to former ATS drug laboratories varies from state to state. Forensic scientists attending the scene have the skills and opportunity to provide more useful information to Councils that can assist in defining whether a property may pose a low or medium/high risk of contamination and health risk to the public. Improving the information provided upon notification of a former ATS drug laboratory will assist in enabling Councils to better understand the potential level of risk and ensure appropriate assessment and remediation methods are adopted.
- Implement and further test/refine the risk matrix developed in this research with relevant housing authorities, health agencies and assessment and remediation consultants. The intention of the risk matrix is to assist in making a preliminary assessment of a property to determine if the property poses a low or medium/high risk of contamination. The level of potential risk can inform decisions about the importance and level of remediation. Understanding this risk early enables more cost-effective assessment and remediation methods to be adopted.
- Undertake further research in relation to pathways of exposure within ATS-contaminated properties. The characterisation of exposure to contamination in ATS-contaminated properties involves understanding and quantifying how, and how much, contamination enters the body via ingestion, dermal contact and inhalation. While some research and information is available to assist in defining some of the specific aspects of these exposure pathways, additional research is required to ensure these exposure pathways are more fully understood and characterised. In addition the relevant exposure pathways need to be

understood for both former ATS drug laboratories as well as properties affected by smoking ATS. Better defining the exposure pathways will further enable the refinement of investigation and remediation criteria.

- Undertake further research into the chronic toxicity of methamphetamine, and other ATS. The current information on methamphetamine is limited to acute studies related to drug use and studies conducted on individuals prescribed medications containing methamphetamine at therapeutic doses, including studies involving sustained-release formulations. There are limitations in this data for the characterisation of dose-response for chronic low-level environmental exposures to methamphetamine. Limited data is available for the assessment of chronic low level environmental exposures to other ATS.

There are also a range of aspects identified in this study that could be further evaluated by experts in other fields such as psychology, sociology, criminal science and environmental science.

PART D: CONCLUSIONS

12.0 CONCLUSIONS

This research has been conducted to obtain information and data to better understand exposures and health effects that may occur as a result of exposure to contamination from ATS clandestine drug laboratories, specifically methamphetamine drug laboratories.

This research has evaluated potential exposure and health effects based on data from three key data sets:

- Interview data from individuals involved in the manufacture as well as Police officers and forensic investigators involved in the detection and assessment of clandestine drug laboratories;
- Characterisation of environmental contamination levels in properties formerly used for the manufacture of methamphetamine; and
- Case-studies where co-located data on levels of environmental contamination, biological data that characterises the potential level of intake as a result of exposure and health effects.

These data comprise a mix of qualitative and quantitative data that provide consistent evidence of the following:

- Activities and behaviours associated with the clandestine manufacture of methamphetamine results in the contamination of surfaces and possessions inside properties, as well as some outdoor areas associated with the disposal of waste.
- There are a number of key areas within residential homes where manufacturing is most likely to occur, and this includes the kitchen, a shed or garage and bathrooms.
- The level of contamination can vary significantly within individual properties. However there is the potential for the level of contamination inside homes to be significantly elevated above current guideline levels.
- The level and spread of contamination within a home depends on a range of different factors that include the method of manufacture, the amount manufactured and characteristics of the property.
- The manufacture of methamphetamine, and exposure to contamination that remain within a former drug laboratory have the potential to result in a range of adverse health effects. The health effects reported include:

    - During manufacture as well as after manufacture: acute skin issues/burns, respiratory and eye problems as well as health effects associated with the use of methamphetamine that include sleep problems; and
    - Within a former clandestine drug laboratory: respiratory problems, including asthma-like symptoms, and behavioural changes are most commonly reported. The behavioural issues are similar to those observed in children removed from active methamphetamine laboratories and include internalising (depression, anxiety and somatisation) problems, externalising (acting out) problems and aggressive behaviour. Other health effects reported included skin and eye problems, and sleep disturbance/issues. The health effects have been described by some participants as similar to methamphetamine withdrawal, but continual.
- Police and forensic investigators understand the potential for exposure and health effects when entering methamphetamine drug laboratories and have procedures to minimise exposure. For the participants involved in this study, and the time period of exposure evaluated, these procedures are preventing exposures to methamphetamine.
- For the general public who may be inadvertently exposed to contamination in former methamphetamine drug laboratories in properties purchased or rented, there is the potential for significant levels of exposure and intake of methamphetamine, particularly for young children. The level of exposure resulting in intakes of methamphetamine by young children may be similar to that reported for children removed from active methamphetamine drug laboratories and low-level long-term adult drug users. Exposures that have occurred in these situations have resulted in adverse health effects in the families evaluated in this study. Some of the health effects have been reported to have resolved following removal from the exposure situation, however more work is required to better understand long-term implications of such exposures.

Based on the information and data evaluated in this research the current understanding of potential risks to the public posed by these properties appears to be underestimated. These risks are further enhanced by difficulties in the detection of, and the effective assessment and remediation of former clandestine drug laboratories in various jurisdictions in Australia.

To further enable the effective evaluation of the risk posed by contamination that may remain in former clandestine drug laboratories the data collected in this research has been used to develop a risk matrix. The risk matrix is deigned to be used as a preliminary tool to determine if a property may be considered to be either low risk or medium/high risk. The level and importance of the assessment and remediation required will differ depending on the level of risk posed to the public.

Further work is required to ensure that contamination that occurs as a result of the clandestine manufacture of methamphetamine in residential properties is properly assessed and effectively remediated to ensure that the health of all future occupants is adequately protected.

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APPENDICES

Appendix A Information Sheets, Consent Forms and Questionnaires used in Interviews with Individuals in Prisons in South Australian and Western Australia

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CRICOS Provider No. 00114A

PARTICIPANT INFORMATION SHEET – ADULTS IN CORRECTIONAL FACILITIES

(PLEASE, RETAIN THIS SHEET FOR FUTURE REFERENCE)

Exposures Associated with Clandestine ATS Drug Laboratories in Australia

You are invited to take part in a research study looking at environmental levels of exposure to amphetamine-type stimulant (ATS) drugs in children and adults and whether there are any effects of exposure. The study will aim to provide information about the levels of environmental exposure within residential homes that are used for the manufacture of ATSs and the potential for these exposures to result in adverse health effects in children, and others, living in the home during or after the manufacture of ATSs.

The research study is being conducted by Jackie Wright for completion of a PhD degree at Flinders University, under the supervision of Associate Professor John Edwards and Associate Professor Stewart Walker from Flinders University and Dr Glenn Porter from the University of Western Sydney.

If you choose to participate, the researcher (Jackie wright) will conduct a face-to-face interview with you, asking you a series of questions about what things you did while cooking drugs, your health and the health of others who may have also been present or living at your home at the same time. If you are not sure about the question being asked please let the interviewed know and it will be rephrased or better explained. You have the right to refuse to answer any question that makes you feel uncomfortable.

The questionnaire does not need your name. It will be given a unique code and information about your age and conviction will be reported separately and then removed from the questionnaire to ensure that you cannot be identified from information obtained from the questionnaire.

Participation in this study will take approximately 1 to 2 hours of your time.

While there are no direct benefits to you associated with this study, the information will benefit the wider community by identifying the levels of exposure in homes where ATS are/have been manufactured, the potential for adverse health effects for those living in, accessing or visiting the home, and the need to establish protocols for the medical evaluation and monitoring of individuals from ATS premises, including those going into correctional services facilities. There are no risks or adverse effects associated with taking part in the study.

Your involvement in this study is entirely voluntary, and you have the right to withdraw yourself from the study at any time. If you decide not to participate in this study or if you withdraw from the study you may do so freely and without prejudice.

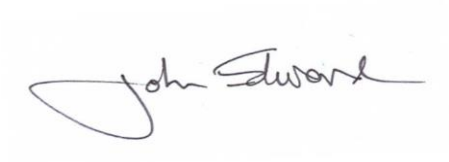
The results of this study may be published in scientific journals and conference papers. All records containing personal information will remain confidential and no information that could lead to your identification will be released or published. If you are interested in seeing the results, a copy of the completed research, or publication, will be made available for you.

If you suffer injury as a result of participation in this research or study, compensation might be paid without litigation. However, such compensation is not automatic and you may have to take legal action to determine whether you should be paid.

Should you require further details about the project, either before, during or after the study, you may contact Ms. Jackie Wright, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 0497 788 014) or Dr. John Edwards, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 08 8204 5016).

This study has been reviewed by the Southern Adelaide Clinical Human Research Ethics Committee. If you wish to discuss the study with someone not directly involved, in particular in relation to policies, your rights as a participant, or should you wish to make a confidential complaint, you may contact the Executive Officer on 8204 6453 or email *research.ethics@health.sa.gov.au*

Yours faithfully



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PARTICIPANT INFORMATION SHEET – ADULTS IN WA CORRECTIONAL FACILITIES

(PLEASE, RETAIN THIS SHEET FOR FUTURE REFERENCE)

Exposures Associated with Clandestine ATS Drug Laboratories in Australia

My name is Jackie Wright and I am a researcher from Flinders University.

I would like to invite you to be part of a research study looking at exposures and health effects associated with the manufacture of amphetamine-type stimulant (ATS) drugs. The aim of the project is to better understand what happens during the manufacture of ATS and how that can then result in chemicals and drugs being present inside a home/building or outside. In addition the project aims to look at where these chemicals are present and if there are any health effects that occur as a result of children or adults being exposed.

The research is being conducted for completion of a PhD degree at Flinders University, under the supervision of Associate Professor John Edwards and Associate Professor Stewart Walker from Flinders University and Dr Glenn Porter from the University of Western Sydney.

If you choose to participate we will conduct a face-to-face interview with you, asking you a series of questions about what things you did while cooking drugs, your health and the health of others who may have also been present or living at your home at the same time. If you are not sure about the question being asked please let us know and it will be rephrased or better explained.

You do not have to speak to me if you don't want to. This is completely your choice. You can stop talking to me at any time by telling me you want to stop. Also you don't have to answer any question that makes you feel uncomfortable; just let me know if you don't want to answer any particular question. You may withdraw from the research project at any time without prejudice.

I will not write down your name or tell the people at this prison what you have said. What you tell me will not have your name attached to it and will be added to what other people have told me. Some of this information will be written into a report and may also be published. If you are interested in seeing the results, a copy of the completed research, or publication, will be made available for you.

However, there are some circumstances in which I have to report what you say in the interview to one of the Department's staff members for example:

a) If you say something about harming yourself or someone else; or

b) If you talk about an offence you have committed and for which you have not been charged or convicted; or

c) If you tell me something about activities that threaten the security or good order of a prison, such as a plan to escape.

While there are no direct benefits to you associated with this study, the information will benefit the wider community by identifying the levels of exposure in homes where ATS are/have been manufactured, the potential for adverse health effects for those living in, accessing or visiting the home. There are no risks or adverse effects associated with taking part in the study.

Participants in this study are insured under Flinders University general and liability protection. This study has been reviewed by the Southern Adelaide Clinical Human Research Ethics Committee.

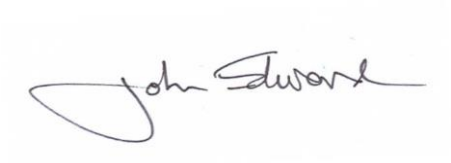
If you have any questions or worries about being interviewed you can contact ACCESS (Administration of Complaints Compliments and Suggestions) using the:

- Free-call Prisoners Telephone System (PTS) available in all prisons; or
- Confidential yellow envelope in all prisons.

For more information on ACCESS, please talk to any prison staff or peer support members.

Alternatively, you can contact Ms. Jackie Wright or Dr. John Edwards at Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 0497 788 014 or 08 8204 5016).

Yours faithfully,



Jackie Wright

PhD Research Student

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CONSENT TO PARTICIPATION IN RESEARCH – ADULTS IN CORRECTIONAL FACILITIES

I …….....

(first or given names) (last name)

request and give consent to my involvement in the research project: **Exposures Associated with Clandestine ATS Drug Laboratories in Australia**

I acknowledge the nature, purpose and contemplated effects of the research project, especially as far as they affect me, have been fully explained to my satisfaction by

---

(first or given names) (last name)

and my consent is given voluntarily.

I acknowledge that the details of the following has/have been explained to me, including indications of risks; anticipation of length of time:

1. Completion of a questionnaire during a face-to-face interview with the researcher

I have understood and am satisfied with the explanations that I have been given.

I have been provided with a written information sheet.

I understand that:

- Any information I provide will remain confidential and will not be used in any way that will reveal my identity.
- My involvement in this research project may not be of any direct benefit to me and that I may withdraw my consent at any stage without affecting my rights or the responsibilities of the researchers in any respect.
- I do not have to provide answers to any questions that I do not feel comfortable with.

I declare that I am over the age of 18 years.

I acknowledge that I have been informed that should I receive an injury as a result of taking part in this study, I may need to start legal action to determine whether I should be paid.

I would like a copy of the research once completed (circle answer): yes/no

---

Signature of Research Participant: .....

Date: .....

I, John Edwards/Jackie Wright have described to .....

the research project and nature and effects of procedure(s) involved. In my opinion he/she understands the explanation and has freely given his/her consent.

Signature: ..... Date: .....

Status in Project: Chief Investigator/Co-Investigator

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CONSENT TO PARTICIPATION IN RESEARCH – ADULTS IN WA CORRECTIONAL FACILITIES

Project Title: Exposures Associated with Clandestine ATS Drug Laboratories in Australia

	Yes
I have read and understood the Participant Information Sheet, or had it read to me. I have been able to ask questions about this study.	
I know that I do not have to talk to the researcher, and that I can stop talking at any time. I know that I can refuse to answer any question and can withdraw from the study at any time.	
I know that this interview is for research/evaluation only and will not make any difference to my release or any other part of my sentence/order.	
I know that what I say may be used in a report or publication but my name will not be in the report or publication. My answers and anything I say will not have my name next to it, nor will anyone be able to work out that the answers provided are mine.	
I know that if I say something about hurting myself or someone else, the researcher will need to tell a staff member.	
I understand that if I discuss crimes that I have committed, but not been charge or convicted for, that the researcher will need to report this.	
I understand that if I talk about something that threatens the security or good order of a prison, the researcher will need to report this.	
I know that if I have any questions or worries about this research, I can contact the researchers on the Participant Information Sheet or use the ACCESS system.	
I declare that I am over 18 years of age.	

I would like a copy of the research once completed (circle answer): yes no

	Participant	**Researcher**	
			Yes
		In my opinion the participant understands the explanation and information provided and has freely given consent	
Signature:			
Name:			Researcher/Chief Investigator
Date:			

Subject code:	

QUESTIONAIRE – ADULT OFFENDERS CONVICTED OF ATS MANUFACTURE

Questionnaire to be completed by researcher during face-to-face interview
Feel free to include any additional information or comments.
Please re-iterate that all information provided will be kept CONFIDENTIAL and will not be able to be used to identify the interviewee in the research project or be provided to any other individual or authority.
The first page (this page) is to be removed from the questionnaire once a code has been assigned to ensure confidentiality is maintained.

Age: _____

Facility: _____

Offence and sentence: _____

_____

Subject code:	

Gender:

How long have you served at this facility?

What sort of drug (or drugs) did you manufacture?

Methamphetamine	Yes ☐	No ☐
Amphetamine	Yes ☐	No ☐
MDMA or ecstacy	Yes ☐	No ☐
Pseudoephedrine	Yes ☐	No ☐
Cannabis	Yes ☐	No ☐
Others (describe)	Yes ☐	No ☐

What method did you use to manufacture the drugs?

Hypophosphorous (hypo, iodine) method	Yes ☐	No ☐
Nazi/Birch (lithium/ammonia) method	Yes ☐	No ☐
Red-phosphorous method	Yes ☐	No ☐
Others (describe)	Yes ☐	No ☐

Where did you manufacture the drugs?

At home	Yes ☐	No ☐
In kitchen	Yes ☐	No ☐
In bathroom	Yes ☐	No ☐
In bedroom	Yes ☐	No ☐
In garage	Yes ☐	No ☐
In shed	Yes ☐	No ☐
In another place (not at home – describe below)	Yes ☐	No ☐
Others (describe)	Yes ☐	No ☐

How did you learn to manufacture the drugs? (do not want names – just an indication of things like, off the internet, a friend showed me, figured it out for myself)

Subject code:	

When you were cooking the drugs, was anyone else around?

Partner/wife/husband	Yes ☐	No ☐
Children	Yes ☐	No ☐
Other family members (note below)	Yes ☐	No ☐
Friends	Yes ☐	No ☐
Others (note below)	Yes ☐	No ☐

Where did you get the precursor chemicals to make the drugs?

Did you know anything about the hazards of manufacturing ATS?
This includes things like:

Fire or explosions	Yes ☐	No ☐
Toxic fumes	Yes ☐	No ☐
Acids and alkalis	Yes ☐	No ☐
Solvents and other chemicals	Yes ☐	No ☐
Being found out	Yes ☐	No ☐
Consequences of being found out	Yes ☐	No ☐
Others:	Yes ☐	No ☐

Where did you store the chemicals used to make the drugs?
Try and be specific, for example:

In a plastic container, with a lid on, on the kitchen bench	Yes ☐	No ☐
In a container, no lid, in the fridge (where in fridge)	Yes ☐	No ☐
On the top shelf in the garage	Yes ☐	No ☐

Describe:

What did you do with the waste (e.g. tip it down the drain, pour it onto the grass)?

Subject code:	

What did you do with the drugs?

When you were cooking – did you wear any protective equipment?

Gloves	Yes ☐	No ☐
Eye protection (glasses, goggles)	Yes ☐	No ☐
Long sleeved shirt and long pants	Yes ☐	No ☐
Apron (cotton or other material – note)	Yes ☐	No ☐
Mask (describe below)	Yes ☐	No ☐
Respirator	Yes ☐	No ☐
Others and additional notes:	Yes ☐	No ☐

When you were cooking – did anyone else who was around wear any protective equipment?

Gloves	Yes ☐	No ☐
Eye protection (glasses, goggles)	Yes ☐	No ☐
Long sleeved shirt and long pants	Yes ☐	No ☐
Apron (cotton or other material – note)	Yes ☐	No ☐
Mask (describe below)	Yes ☐	No ☐
Respirator	Yes ☐	No ☐
Others and additional notes:	Yes ☐	No ☐

What modifications did you make to your home (or the building) you used to cook the drugs (e.g. put in ventilation fan, sealed up and blacked/blocked out windows, security system)?

Subject code:	

While actually cooking the drugs, did you experience any of the following? (also note how severe)

Cough	Yes	☐	No	☐
Asthma	Yes	☐	No	☐
Watering eyes	Yes	☐	No	☐
Sore eyes	Yes	☐	No	☐
Skin problems	Yes	☐	No	☐

Other health effects - describe (as relevant)

When not cooking, but living at home, did you experience any of the following? (also note how severe and for how long after cooking)

Persistent cough	Yes	☐	No	☐
Asthma	Yes	☐	No	☐
Sore eyes	Yes	☐	No	☐
Skin problems	Yes	☐	No	☐
Trouble sleeping	Yes	☐	No	☐
Unusual behaviour (e.g. aggression, depression, moodiness etc)	Yes	☐	No	☐

Other health effects - describe (as relevant)

Did any of the health effects continue after you stopped cooking? Yes ☐ No ☐

If yes, please describe and indicate for how long after cooking did the effects persist/last?

Subject code:	

Did anyone else who lived with you (or your friends) experience any of the above health effects? Yes ☐ No ☐
If yes, please describe?

Do you feel generally healthy at present? Yes ☐ No ☐
If not, what health problems do you currently have?

What incentives did you have to manufacture the drugs (i.e. why did you cook the drugs)? (e.g. for money, for your own use)

What were the things you were worried about when you were manufacturing the drugs? (e.g. being caught, getting the chemicals to make the drugs, blowing things up or starting a fire)

How do you now feel about manufacturing drugs?

Subject code:	

Is there anything else you wish to say or make comment on?

Completion of face-to-face questions

During and following completion of interview note any observations made by the interviewer during the course of the interview (e.g. restless, tired, twitchy etc.)

Appendix B Information Sheets, Consent Forms and Questionnaires used in Interviews and for Data Collection from Police and Forensic Investigators

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CRICOS Provider No. 00114A

PARTICIPANT INFORMATION SHEET – POLICE AND FORENSIC INVESTIGATORS

(PLEASE, RETAIN THIS SHEET FOR FUTURE REFERENCE)

Exposures Associated with Clandestine ATS Drug Laboratories in Australia

My name is Jackie Wright and I am a researcher from Flinders University.

I would like to invite you to be part of a research study looking at exposures and health effects associated with the manufacture of amphetamine-type stimulant (ATS) drugs. The aim of the project is to better understand what happens during the manufacture of ATS and how that can then result in chemicals and drugs being present inside a home/building or outside. In addition the project aims to look at where these chemicals are present and if there are any health effects that occur as a result of children or adults being exposed.

The research is being conducted for completion of a PhD degree at Flinders University, under the supervision of Associate Professor John Edwards and Associate Professor Stewart Walker from Flinders University and Dr Glenn Porter from the University of Western Sydney.

If you choose to participate, you will be provided with a questionnaire to be completed and returned to the researched (Jackie Wright) in an envelope provided. Alternatively the researcher (Jackie Wright) may conduct a face-to-face interview with you, asking you the questions in the questionnaire. The questions relate to things you have observed and perceived during your duties associated with the seizure and assessment/processing of ATS drug laboratories. The focus of the questions relates to hazards and contaminants (chemicals, drugs and waste products) and well as health effects observed or experienced.

If you are not sure about the question being asked please let the interviewer/researcher know and it will be rephrased or better explained. You have the right to refuse to answer any question that makes you feel uncomfortable.

The questionnaire does not need your name. It will be given a unique code and information about your age and location and the first page of the questionnaire will be removed to ensure that you cannot be identified from information obtained from the questionnaire.

Participation in this study will take approximately 20 minutes of your time.

While there are no direct benefits to you associated with this study, the information will benefit the wider community by identifying the levels of exposure in homes where ATS are/have been manufactured, the potential for adverse health effects for those living in, accessing or visiting the

home. There are no risks or adverse effects associated with taking part in the study. Participants in this study are insured under Flinders University general and liability protection. Participants in this study are insured under Flinders University general and liability protection.

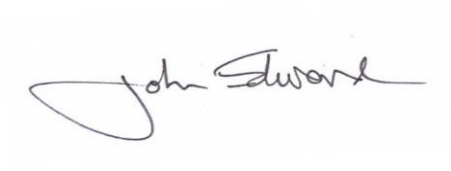
Your involvement in this study is entirely voluntary, and you have the right to withdraw yourself from the study at any time. If you decide not to participate in this study or if you withdraw from the study you may do so freely and without prejudice.

The results of this study may be published in scientific journals and conference papers. All records containing personal information will remain confidential and no information that could lead to your identification will be released or published. If you are interested in seeing the results, a copy of the completed research, or publication, will be made available for you.

This study has been reviewed by the Southern Adelaide Clinical Human Research Ethics Committee. If you wish to discuss the study with someone not directly involved, in particular in relation to policies, your rights as a participant, or should you wish to make a confidential complaint, you may contact the Executive Officer on 8204 6453 or email *research.ethics@health.sa.gov.au*

Should you require further details about the project, either before, during or after the study, you may contact Ms. Jackie Wright, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 0497 788 014) or Dr. John Edwards, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 08 8204 5016).

Yours faithfully,



Jackie Wright

PhD Research Student

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CONSENT TO PARTICIPATION IN RESEARCH – POLICE AND FORENSIC INVESTIGATORS

I .....

(first or given names) (last name)

request and give consent to my involvement in the research project: **Exposures Associated with Clandestine ATS Drug Laboratories in Australia**

I acknowledge the nature, purpose and contemplated effects of the research project, especially as far as they affect me, have been fully explained to my satisfaction by

.....

(first or given names) (last name)

and my consent is given voluntarily.

I acknowledge that the details of the following has/have been explained to me, including indications of risks; anticipation of length of time:

1. Completion of a questionnaire either during a face-to-face interview or completion separately and returning the questionnaire (and this consent form) to the researcher in the provided envelope.

I have understood and am satisfied with the explanations that I have been provided.

I have been provided with a written information sheet.

I understand that:

- Any information I provide will remain confidential and will not be used in any way that will reveal my identity.
- My involvement in this research project may not be of any direct benefit to me and that I may withdraw my consent at any stage without affecting my rights or the responsibilities of the researchers in any respect.
- I do not have to provide answers to any questions that I do not feel comfortable with.

I declare that I am over the age of 18 years.

I would like a copy of the research once completed (circle answer): yes/no

---

Signature of Research Participant: .....

Date: .....

I, John Edwards/Jackie Wright have described to .....

the research project and nature and effects of procedure(s) involved. In my opinion he/she understands the explanation and has freely given his/her consent.

Signature: ..... Date: .....

Status in Project: Chief Investigator/Co-Investigator

Subject code:	

QUESTIONAIRE – POLICE OFFICERS AND FORENSIC INVESTIGATORS INVOLVED IN SEIZURE AND ASSESSMENT OF ATS DRUG LABORATORIES

Questionnaire to be completed by researcher during face-to-face interview or by the individual and returned in envelope provided (with signed consent form) to the researcher
Feel free to include any additional information or comments.
Note that all information provided will be kept CONFIDENTIAL.

Age: _____

Location: _____

Rank (where relevant) and Duties/Role: _____

_____

_____

Gender: _____

How long have you worked in this area (drug labs)?

How many drug laboratory seizures/detections have you been involved in? (approximate number)

What sort of drug manufacturing processes have you come across?

Methamphetamine	Yes ☐	No ☐
Amphetamine	Yes ☐	No ☐
MDMA or ecstacy	Yes ☐	No ☐
Pseudoephedrine	Yes ☐	No ☐
Cannabis	Yes ☐	No ☐
Others (describe)	Yes ☐	No ☐

How many of the lab seizures/detections involved the manufacture of ATS?

What methods for the manufacture of AST have you come across/dealt with during the execution of your job/duties? – where more than 1 please rank prevalence observed from most common (rank of 1) to least common (rank of 3 or more)

Hypophosphorous (hypo, iodine) method	Yes ☐	No ☐	Rank ☐
Nazi/Birch (lithium/ammonia) method	Yes ☐	No ☐	Rank ☐
Red-phosphorous method	Yes ☐	No ☐	Rank ☐
Others (describe and rank prevalence)	Yes ☐	No ☐	Rank ☐

Where have ATS drug laboratories been found? Please rank prevalence observed from most common (rank of 1) to least common (e.g. rank of 3 or more as required)

Residential home	Yes ☐	No ☐	Rank ☐
Residential unit or townhouse	Yes ☐	No ☐	Rank ☐
Kitchen	Yes ☐	No ☐	Rank ☐
Bathroom	Yes ☐	No ☐	Rank ☐
Bedroom	Yes ☐	No ☐	Rank ☐
Shed or garage	Yes ☐	No ☐	Rank ☐
Commercial property (incl. warehouse)	Yes ☐	No ☐	Rank ☐
Caravan	Yes ☐	No ☐	Rank ☐
Hotel room	Yes ☐	No ☐	Rank ☐
Outdoor/bush site	Yes ☐	No ☐	Rank ☐
Motor vehicle (describe)	Yes ☐	No ☐	Rank ☐
Others (describe and rank prevalence)	Yes ☐	No ☐	Rank ☐

When ATS drug labs were detected/seized, how often were other people around/living at the same location? (general perception of prevalence e.g. 20% of labs)

Partner/wife/husband

Children

Other family members (note below)

Friends

Other drug criminals

Others (describe below)

Can you describe the range of drug cooks arrested during your work and any observations you have of their general behaviour

Signs of being drug user (paranoid, hallucinations etc.)	Yes ☐	No ☐
Very energetic and fidgety	Yes ☐	No ☐
Aggressive or violent	Yes ☐	No ☐
Depressed	Yes ☐	No ☐
Concerned about family or friends	Yes ☐	No ☐

Other (describe):

Have you attended ATS drug labs where the following have been a significant problem:

Fire or explosions	Yes ☐	No ☐
Toxic fumes	Yes ☐	No ☐
Strong chemical/unusual odours (describe below)	Yes ☐	No ☐

Where/how have you observed the storage of chemicals and precursors in the drug labs? Try and be specific, for example:

In a container, with a lid on, on the kitchen bench	Yes ☐	No ☐
In a container, no lid, in the fridge (where in fridge)	Yes ☐	No ☐
On the top shelf in the garage	Yes ☐	No ☐

Describe:

Where have you observed waste materials to be disposed? – where more than 1 please rank prevalence observed from most common (rank of 1) to least common (rank of 3 or more)

Drain (toilet/bathroom or laundry sink)	Yes ☐	No ☐	Rank ☐
Outside – dumped down drain	Yes ☐	No ☐	Rank ☐
Outside – dumped on soil or in pit	Yes ☐	No ☐	Rank ☐
In drums – dumped elsewhere?	Yes ☐	No ☐	Rank ☐

Others (describe and rank prevalence)

What types of modifications have you observed in homes used to manufacture ATS (e.g. put in ventilation fan, sealed up and blacked/blocked out windows, security system)?

What observations would you make of the drug cooks in relation to general health, in particular if the following are noticeable or mentioned at the time of lab detection/seizure (and rank prevalence):

Cough or asthma	Yes ☐	No ☐	Rank ☐
Evidence of burns on hands/arms/feet etc.	Yes ☐	No ☐	Rank ☐
Evidence of sore or irritated eyes	Yes ☐	No ☐	Rank ☐
Other (describe)	Yes ☐	No ☐	Rank ☐

What observations would you make of children found in drug labs in relation to general health, in particular if the following are noticeable or mentioned at the time of lab detection/seizure (and rank prevalence):

Cough or asthma	Yes ☐	No ☐	Rank ☐
Evidence of burns on hands/arms/feet etc.	Yes ☐	No ☐	Rank ☐
Evidence of sore or irritated eyes	Yes ☐	No ☐	Rank ☐
Poor personal hygiene	Yes ☐	No ☐	Rank ☐
Other (describe)	Yes ☐	No ☐	Rank ☐

When entering an ATS drug laboratory, what sort of PPE do you typically wear:

Gloves	Yes ☐	No ☐
Eye protection (glasses, goggles)	Yes ☐	No ☐
Chemical resistant overalls	Yes ☐	No ☐
Mask (describe below)	Yes ☐	No ☐
Respirator	Yes ☐	No ☐
Others and additional notes:	Yes ☐	No ☐

Have you been exposed in an ATS drug lab, or to chemicals for use in the manufacture of ATS without the use of any PPE (i.e. when a drug lab is detected in the course of other duties)

Yes ☐ No ☐

Describe situation:

Have you experienced any health effects from your duties involving ATS drug labs (please describe)

Cough	Yes ☐	No ☐
Asthma	Yes ☐	No ☐
Sore or watering eyes	Yes ☐	No ☐
Skin problems	Yes ☐	No ☐

Other health effects - describe (as relevant)

Have you had any long-term health effects that may be associated with an exposure to a drug lab or chemicals from a drug lab? Describe (including treatment received)

How do you now feel about clandestine drug manufacturing? (after your personal opinion)

Is there anything else you wish to say or make comment on?

Completion of questions

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PARTICIPANT INFORMATION SHEET – POLICE AND EMERGENCY PERSONNEL

(PLEASE, RETAIN THIS SHEET FOR FUTURE REFERENCE)

Exposures Associated with Clandestine ATS Drug Laboratories in Australia

You are invited to take part in a research study looking at environmental levels of exposure to amphetamine-type stimulant (ATS) drugs in children and adults and whether there are any effects of exposure. The study will aim to provide information about the levels of environmental exposure within residential homes that are used for the manufacture of ATSs and the potential for these exposures to result in adverse health effects in emergency personnel, including Police attending these premises (with or without personal protective equipment), children, and others, living in the home during or after the manufacture of ATS.

The research study is being conducted by Jackie Wright for completion of a PhD degree at Flinders University, under the supervision of Associate Professor John Edwards and Associate Professor Stewart Walker from Flinders University and Dr Glenn Porter from the University of Western Sydney.

If you choose to participate, you will be asked to provide some details about your general health. You will also be asked to provide a sample of urine or hair (cut close to the scalp). The urine or hair sample will be analysed to allow us to measure the amount of ATS that has been absorbed into the body from environmental exposure. The questionnaire and urine/hair sample do not need your name as they will be given a unique code that is based on your age and gender. This code will not allow you to be identified in any data files or reports.

Participation in this study will take approximately 1 hour of your time.

While there are no direct benefits to you associated with this study, the information will benefit the Police and other Emergency Services in understanding the levels of contamination to which emergency personnel and the wider community are exposed. This includes the potential for adverse health effects (harm) for those accessing the property (for law enforcement purposes or attending to fires or other medical emergencies), living in or visiting the home. There are no risks or adverse effects associated with taking part in the study.

Your involvement in this study is entirely voluntary, and you have the right to withdraw from the study at any time. If you decide not to participate in this study you may do so freely and without prejudice.

The results of this study may be published in scientific journals and conference papers. All records containing personal information will remain confidential and no information that could lead to your identification will be released or published.

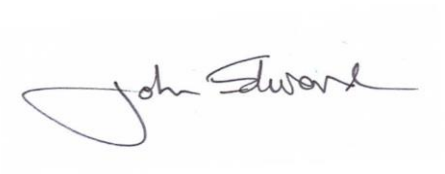
You will be informed of the results of the analysis of your samples. You should note that our research may reveal evidence of potential adverse health outcomes associated with your chemical exposure, in which case you will be advised to seek medical attention.

If you suffer injury as a result of participation in this research or study, compensation might be paid without litigation. However, such compensation is not automatic and you may have to take legal action to determine whether you should be paid.

Should you require further details about the project, either before, during or after the study, you may contact Ms. Jackie Wright, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 0487 622 551) or Dr. John Edwards, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 08 8204 5016).

This study has been reviewed by the Southern Adelaide Clinical Human Research Ethics Committee. If you wish to discuss the study with someone not directly involved, in particular in relation to policies, your rights as a participant, or should you wish to make a confidential complaint, you may contact the Executive Officer on 8204 6453 or email *research.ethics@health.sa.gov.au*

Yours faithfully



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CONSENT TO PARTICIPATION IN RESEARCH - POLICE AND EMERGENCY PERSONNEL

I .....

(first or given names) (last name)

request and give consent to my involvement in the research project: **Exposures Associated with Clandestine ATS Drug Laboratories in Australia**

I acknowledge the nature, purpose and contemplated effects of the research project, especially as far as they affect me, have been fully explained to my satisfaction by

.....

(first or given names) (last name)

and my consent is given voluntarily.

I acknowledge that the details of the following has/have been explained to me, including indications of risks; any discomfort involved; anticipation of length of time; and the frequency with which they will be performed:

1. Collection of a urine or hair sample for analysis.
2. Completion of a questionnaire.

I have understood and am satisfied with the explanations that I have been given.

I have been provided with a written information sheet.

I understand that my involvement in this research project may not be of any direct benefit to me and that I may withdraw my consent at any stage without affecting my rights or the responsibilities of the researchers in any respect.

I declare that I am over the age of 18 years.

I acknowledge that I have been informed that should I receive an injury as a result of taking part in this study, I may need to start legal action to determine whether I should be paid.

Signature of Research Participant: .....

Date: .....

I, John Edwards/Jackie Wright have described to .....

the research project and nature and effects of procedure(s) involved. In my opinion he/she understands the explanation and has freely given his/her consent.

Signature: ..... Date: .....

Status in Project: Chief Investigator/Co-Investigator

QUESTIONAIRE – EMERGENCY PERSONNEL

Answer what you feel comfortable answering.
Feel free to include any additional information or comments.
All information provided will be kept CONFIDENTIAL and will not be able to be used to identify you in the research project.

Age:

Gender:

What were you doing when you were exposed to chemicals at an ATS drug lab?

How were you exposed (breath it in, get chemicals on your skin etc.)?

How long were you exposed?

Were you wearing any PPE?

What did you do when you realised you were exposed to chemicals?

What health effects did you experience when in the drug lab, or after you came out of the drug lab? describe

If you got medical help, what did you get treated for and how long were you treated?

If you did not get any medical help, do you have any health concerns related to your exposure?

Have you been exposed to chemicals in a drug in the past? If so, when, and were there any health problems related to that exposure?

When complete please hand back to the researcher

QUESTIONAIRE – ADULTS PROVIDING HEALTHY HAIR SAMPLES

All information provided will be kept CONFIDENTIAL and will not be able to be used to identify you in the research project or be provided to any other individual or authority.

Age: _____

Gender: _____

Hair colour: _____

Confirmed no exposure to amphetamine type stimulants: Y N

When complete please hand back to the researcher

Appendix C Information Sheets, Consent Forms and Questionnaires used in Interviews and for Data Collection from Individuals Involved in Case Studies

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PARTICIPANT INFORMATION SHEET - HOMEOWNERS

(PLEASE, RETAIN THIS SHEET FOR FUTURE REFERENCE)

Exposures Associated with Clandestine ATS Drug Laboratories in Australia

You are invited to take part in a research study looking at environmental levels of exposure to amphetamine-type stimulant (ATS) drugs in children and adults and whether there are any effects of exposure. The study will aim to provide information about the levels of environmental exposure within residential homes that are/have been used for the manufacture of ATSs and the potential for these exposures to result in adverse health effects in children, and others, living in the home during or after the manufacture of ATS.

The research study is being conducted by Jackie Wright for completion of a PhD degree at Flinders University, under the supervision of Associate Professor John Edwards and Associate Professor Stewart Walker from Flinders University and Dr Glenn Porter from the University of Western Sydney.

If you choose to participate, you will be asked to provide access to your home for the purpose of collecting environmental samples from inside the home. These samples will include those collected by wiping the surface of walls, floors, benches and other items (such as toys and bedding) that are in the home. There will be no damage caused to your home or any possessions during the sampling. Sampling will take approximately 1 to 2 hours of time. These samples will be analysed to allow us to measure the amount of ATS that is on a range of surfaces inside the home. The environmental samples must have your home address on the front page and label, but this information will be removed as soon as we can allocate an identification code to your home. This identification code will not allow your home to be identified in any data files or reports.

While there are no direct benefits to you associated with this study, the information will benefit the wider community by identifying the levels of exposure in homes where ATS are/have been manufactured. There are no risks or adverse effects associated with taking part in the study.

Your involvement in this study is entirely voluntary, and you have the right to withdraw from the study at any time. If you decide not to participate in this study you may do so freely and without prejudice.

The results of this study may be published in scientific journals and conference papers. All records containing personal/property information will remain confidential and no information that could lead to your identification will be released or published.

If you suffer injury as a result of participation in this research or study, compensation might be paid without litigation. However, such compensation is not automatic and you may have to take legal action to determine whether you should be paid.

Should you require further details about the project, either before, during or after the study, you may contact Ms. Jackie Wright, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 0487 622 551) or Dr. John Edwards, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 08 8204 5016).

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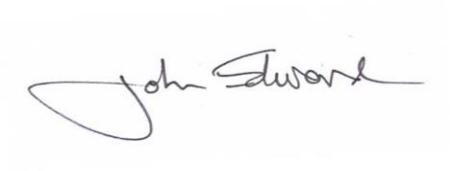
Yours faithfully



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CONSENT TO PARTICIPATION IN RESEARCH - HOMEOWNERS

I .....

(first or given names) (last name)

request and give consent to my involvement in the research project: **Exposures Associated with Clandestine ATS Drug Laboratories in Australia**

I acknowledge the nature, purpose and contemplated effects of the research project, especially as far as they affect me, have been fully explained to my satisfaction by

.....

(first or given names) (last name)

and my consent is given voluntarily.

I acknowledge that the details of the following has/have been explained to me, including indications of risks; any discomfort involved; anticipation of length of time; and the frequency with which they will be performed:

1. Access to your home for the purpose of collecting environmental samples

I have understood and am satisfied with the explanations that I have been given.

I have been provided with a written information sheet.

I understand that my involvement in this research project may not be of any direct benefit to me and that I may withdraw my consent at any stage without affecting my rights or the responsibilities of the researchers in any respect.

I declare that I am over the age of 18 years.

I acknowledge that I have been informed that should I receive an injury as a result of taking part in this study, I may need to start legal action to determine whether I should be paid.

Signature of Research Participant: .....

Date: .....

I, John Edwards/Jackie Wright have described to .....

the research project and nature and effects of procedure(s) involved. In my opinion he/she understands the explanation and has freely given his/her consent.

Signature: ..... Date: .....

Status in Project: Chief Investigator/Co-Investigator

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PARTICIPANT INFORMATION SHEET – ADULTS AND CHILDREN FROM ATS HOMES

(PLEASE, RETAIN THIS SHEET FOR FUTURE REFERENCE)

Exposures Associated with Clandestine ATS Drug Laboratories in Australia

You are invited to take part in a research study looking at environmental levels of exposure to amphetamine-type stimulant (ATS) drugs in children and adults and whether there are any effects of exposure. The study will aim to provide information about the levels of environmental exposure within residential homes that are used for the manufacture of ATSs and the potential for these exposures to result in adverse health effects in children, and others, living in the home during or after the manufacture of ATS.

The research study is being conducted by Jackie Wright for completion of a PhD degree at Flinders University, under the supervision of Associate Professor John Edwards and Associate Professor Stewart Walker from Flinders University and Dr Glenn Porter from the University of Western Sydney.

If you choose to participate, you will be asked to complete a questionnaire regarding you and/or your child's general health, and to complete a check-list relating to your, and/or your child's behaviour. You will also be asked to provide a small sample of hair (cut close to the scalp – at the back near the top of the head) from yourself and/or your child. The hair sample will be analysed to allow us to measure the amount of ATS that has been absorbed into the body from environmental exposure. The questionnaire, check-list and hair sample do not need your name as they will be given a unique code that is based on your (or your child's) address, age and gender. This code will not allow you or your child to be identified in any data files or reports.

Participation in this study will take approximately 1 to 2 hours of your time.

While there are no direct benefits to you or your child associated with this study, the information will benefit the wider community by identifying the levels of exposure in homes where ATS are/have been manufactured, the potential for adverse health effects for those living in, accessing or visiting the home, and the need to establish protocols for the medical evaluation and monitoring of children removed from ATS homes. There are no risks or adverse effects associated with taking part in the study.

Your involvement in this study is entirely voluntary, and you have the right to withdraw yourself and/or your child from the study at any time. If you decide not to participate in this study or if you withdraw your child from the study you may do so freely and without prejudice.

The results of this study may be published in scientific journals and conference papers. All records containing personal information will remain confidential and no information that could lead to your identification will be released or published.

You will be informed of the results of the analysis of your (or your child's) samples. You should note that our research may reveal evidence of potential adverse health outcomes associated with your (or your child's) chemical exposure, in which case you will be advised to seek medical attention.

If you suffer injury as a result of participation in this research or study, compensation might be paid without litigation. However, such compensation is not automatic and you may have to take legal action to determine whether you should be paid.

Should you require further details about the project, either before, during or after the study, you may contact Ms. Jackie Wright, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 0487 622 551) or Dr. John Edwards, Environmental Health, Flinders University, GPO Box 2100, Adelaide SA 5001 (phone 08 8204 5016).

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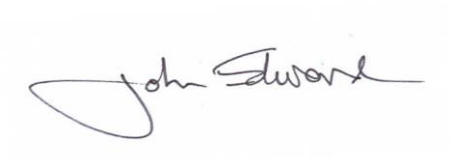
Yours faithfully



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CONSENT TO PARTICIPATION IN RESEARCH – ADULTS/PARENTS FROM ATS HOMES

I …….....

(first or given names) (last name)

request and give consent to my involvement in the research project: **Exposures Associated with Clandestine ATS Drug Laboratories in Australia**

I acknowledge the nature, purpose and contemplated effects of the research project, especially as far as they affect me, have been fully explained to my satisfaction by

---

(first or given names) (last name)

and my consent is given voluntarily.

I acknowledge that the details of the following has/have been explained to me, including indications of risks; any discomfort involved; anticipation of length of time; and the frequency with which they will be performed:

1. Providing a hair sample for analysis
2. Completion of a questionnaire and check-list

I have understood and am satisfied with the explanations that I have been given.

I have been provided with a written information sheet.

I understand that my involvement in this research project may not be of any direct benefit to me and that I may withdraw my consent at any stage without affecting my rights or the responsibilities of the researchers in any respect.

I declare that I am over the age of 18 years.

I acknowledge that I have been informed that should I receive an injury as a result of taking part in this study, I may need to start legal action to determine whether I should be paid.

Signature of Research Participant: .....

Date: .....

I, John Edwards/Jackie Wright have described to .....

the research project and nature and effects of procedure(s) involved. In my opinion he/she understands the explanation and has freely given his/her consent.

Signature: ..... Date: .....

Status in Project: Chief Investigator/Co-Investigator

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CONSENT BY A THIRD PARTY TO PARTICIPATION IN RESEARCH – CHILDREN FROM ATS HOMES

I .....
(first or given names) (last name)

request and give consent to ..... 's involvement in the research
(first or given names) (last name)

project: **Exposures Associated with Clandestine ATS Drug Laboratories in Australia**

I acknowledge the nature, purpose and contemplated effects of the research project, especially as far as they affect .....
(first or given names) (last name)

have been fully explained to my satisfaction by .....
(first or given names) (last name)

and my consent is given voluntarily.

I acknowledge that the details of the following has/have been explained to me, including indications of risks; any discomfort involved; anticipation of length of time; and the frequency with which they will be performed:

1. Collection of a hair sample for analysis.
2. Completion of a questionnaire and child behaviour check-list.

I have understood and am satisfied with the explanations that I have been given.

I have been provided with a written information sheet.

I understand that ..... 's involvement in this research
(first or given names) (last name)

project may not be of any direct benefit to him/her and that I may withdraw my consent at any stage without affecting his/her rights or the responsibilities of the researchers in any respect.

I declare that I am over the age of 18 years.

I acknowledge that I have been informed that should he/she receive an injury as a result of taking part in this study, legal action may need to be taken to determine whether he/she should be paid.

Signature of parent, legal
guardian or authorised person: .....

Date: .....

Relationship to participant: .....

I assent to taking part in this study

Signature of subject: .....

Date: .....

I, John Edwards/Jackie Wright have described to .....
the research project and nature and effects of procedure(s) involved. In my opinion he/she understands the explanation and has freely given his/her consent.

Signature: ..... Date: .....

Status in Project: Chief Investigator/Co-Investigator

QUESTIONAIRE – ADULTS AND TEENAGERS (14 years and over) FROM ATS HOMES

Answer what you feel comfortable answering.
Feel free to include any additional information or comments.
All information provided will be kept CONFIDENTIAL and will not be able to be used to identify you in the research project or be provided to any other individual or authority.

Age: _____

Gender: _____

Hair Colour: _____

How long have you lived at your home? _____

Have you used amphetamine-type drugs in the past? Yes ☐ No ☐

If so, have you used these drugs in your home? Yes ☐ No ☐

Do you feel generally healthy at present? Yes ☐ No ☐
If not, what health problems do you currently have?

_____
_____
_____
_____
_____
_____

Have you had any of the following when living in your home?

Persistent cough	Yes ☐	No ☐
Asthma	Yes ☐	No ☐
Watering eyes	Yes ☐	No ☐
Sore eyes	Yes ☐	No ☐
Skin problems	Yes ☐	No ☐
Trouble sleeping	Yes ☐	No ☐
Unusual behaviour (e.g. aggression, depression, moodiness etc)	Yes ☐	No ☐

Describe (as relevant)

_____
_____
_____
_____
_____
_____

Any other health problems when living at home? Describe Yes ☐ No ☐

_____
_____
_____
_____
_____
_____

When complete please hand back to the researcher

QUESTIONAIRE – PARENTS TO COMPLETE FOR CHILDREN FROM ATS HOMES

Answer what you feel comfortable answering.
Feel free to include any additional information or comments.
All information provided will be kept CONFIDENTIAL and will not be able to be used to identify you in the research project or be provided to any other individual or authority.

Age of Child:

Gender:

Hair Colour:

How long has your child lived in the home used to make drugs?

Do you feel that your child is healthy at present? Yes ☐ No ☐
If not, what health problems do they currently have?

Has your child had any of the following when living at home?

Persistent cough	Yes ☐	No ☐
Asthma	Yes ☐	No ☐
Watering eyes	Yes ☐	No ☐
Sore eyes	Yes ☐	No ☐
Skin problems	Yes ☐	No ☐
Trouble sleeping	Yes ☐	No ☐
Irritability/more crying than normal	Yes ☐	No ☐
Unusual behaviour (e.g. aggression, withdrawn etc)	Yes ☐	No ☐

Describe (as relevant)

Any other health problems when living at home? Describe Yes ☐ No ☐

When complete please hand back to the researcher