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Prepared by

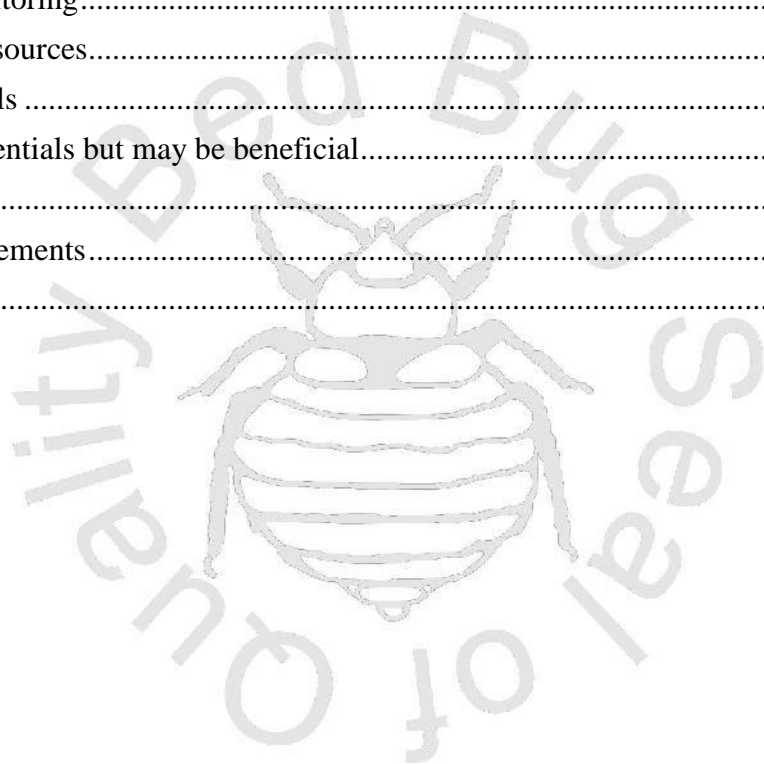
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Optimising furniture to reduce the impact of an infestation of bedbugs

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About bedbugs

Bedbugs are blood feeding parasites that preferentially feed on humans. They are a persistent pest and have developed a number of highly evolved abilities to remain close to humans.

They are a pest of exposure and only arrive in your home if you have come into contact with them external to the property or if an adjoining property has a significant infestation.



Close up of an adult bedbug, when fed they become oval in shape but are usually only seen when they are thin and flat.



Close up a juvenile bedbug, the characteristic dark brown colour develops as the bedbug matures and younger samples may appear translucent.



Close up a nesting area showing many of the classic signs of bedbugs, live samples, cast skins and faecal trace signs.



Close up of a bed slat illustrating a build-up of faecal traces and some egg casings close to the joint in the wood.

Bedbugs have been documented as pests since the 17th century although they have been around for much longer and most likely followed man out of the caves millennia ago. Bedbugs were common in the UK prior to World War II, after which time widespread use of synthetic insecticides such as DDT and public education greatly

reduced their numbers, at one stage though in the 1930's 30% of all homes in London were infested.

In the past decade, bedbugs have begun making a comeback across the world, although they are not considered to be a major pest or health hazard they can be highly unpleasant to live with and can cause a severe lack of sleep. International travel and commerce are thought to facilitate the spread because eggs, young, and adult bedbugs are readily transported in luggage, clothing, bedding, and furniture. Bedbugs can infest airplanes, ships, trains, and buses, recent cases that we have worked on have been traced back to travel where the source was identified to be the return journey rather than an infested room.

Bedbugs are most frequently found in dwellings with a high rate of occupant turnover, such as hotels, motels, hostels, dormitories, shelters, apartment complexes, tenements, and prisons. Such infestations usually are not a reflection of poor hygiene or bad housekeeping but that a previous occupant had come into contact with them at some stage.

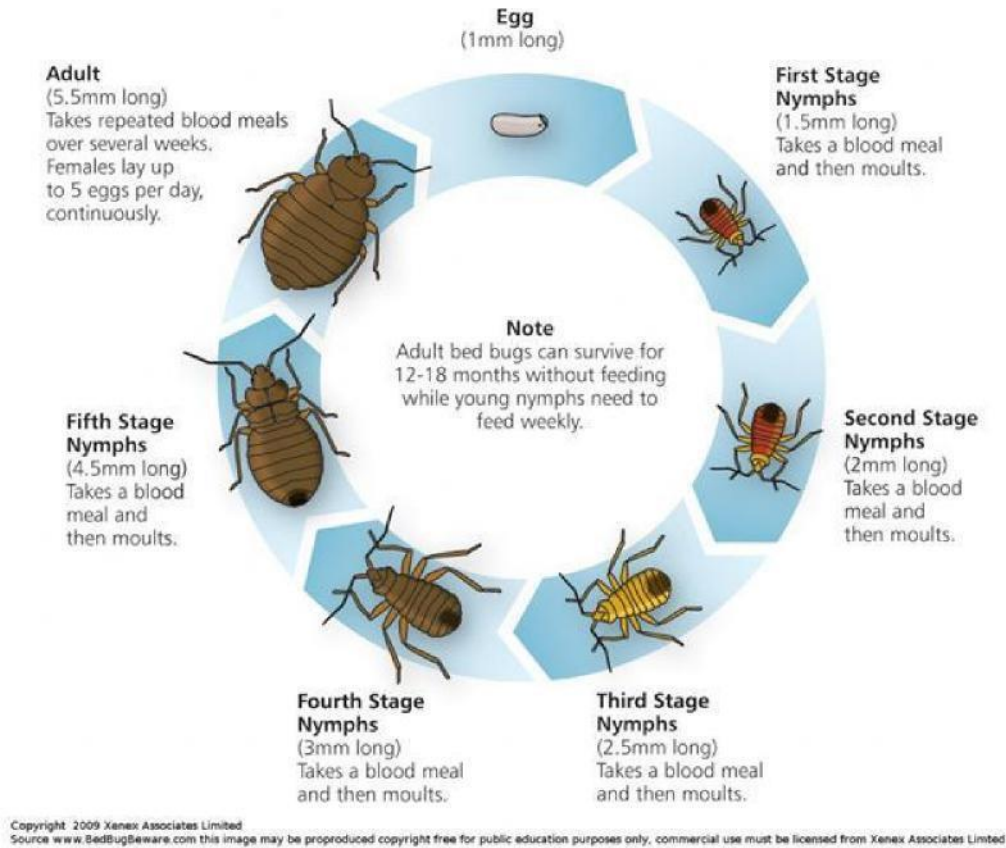
Adult bedbugs are brown to reddish-brown, oval-shaped, flattened, and about 3mm to 5mm long. Their flat shape enables them to readily hide in cracks and crevices. In some cases colonies have been found in places where it is difficult to insert a sheet of paper.

Life Cycle

Female bedbugs lay from one to twelve eggs per day, and the eggs are deposited on rough surfaces or in crack and crevices. The eggs are coated with a sticky substance so they adhere to the substrate. Eggs hatch in around 10 days, and nymphs can immediately begin to feed. They require a blood meal in order to molt and develop into the next stage. Bedbugs reach maturity after five molts. Developmental time (egg to adult) is affected by temperature and takes about 21 days at 30°C to 120 days at 18°C. The nymphal period is greatly prolonged when food is scarce. The adult's lifespan may encompass 12-18 months and they are known to be able to survive for 12 months between feeds although if a source of food is present they will always be active.

Life Cycle of the Bed Bug

Cimex lectularius



Habits

Bedbugs are fast moving insects that tend to be most active at night when we rest; they feed on blood using a piercing mouth part the entry of which is often unnoticed. Nymphs may become engorged with blood within three minutes, whereas a full-grown bedbug usually feeds for ten to fifteen minutes. They then crawl away to a hiding place to digest the meal; a full meal may take 3 or 4 days to digest.

Bedbugs hide during the day in dark protected sites, they prefer fabric, wood, and paper surfaces. They usually occur in fairly close proximity to the host, although they can travel great distances if needed. Bedbugs initially can be found about tufts, seams, and folds of mattresses, later spreading to crevices in the bedstead. In heavier infestations, they also may occupy hiding places further from the bed. They may hide in window and door frames, electrical boxes, floor cracks, baseboards, furniture, and under the tack board of wall-to-wall carpeting. Bedbugs often crawl upward to hide in pictures, wall hangings, drapery pleats, loosened wallpaper, cracks in plaster, and ceiling mouldings.

Injury

The bite is painless at the time but can cause the skin to become irritated and inflamed. Individuals differ greatly in both the extent and timing of their response to a bite. A small, hard, swollen, white welt may develop at the site of each bite which can occur in rows or batches of three or four but also in single reactions. This is often accompanied by severe itching that lasts for several hours to days, in rare cases an allergic reaction may follow, in such cases seek medical attention immediately. The morphology of bites is highly variable and it is almost impossible to diagnose on bites alone.

It is believed that 1 in 10 people show no signs of biting, often leading to the myth that they only attack certain people and about 60% of people do not appear to show signs at the start of an infestation. Cases of extreme reaction seem to be on the increase and affect as many as 2 in 10 people. Given the extent of some of the documented infestation in commercial properties it is clear that waiting for bites to indicate an issue is too unreliable and results in infestations which progress beyond simple and fast control.

Confirming signs

There are only three easily confirmed signs of bedbugs, these are:

- Live samples – although cryptic in nature and small at the nymphal stage they are detectable by those with good eye sight.
- Cast Skins – due to the incomplete metamorphic life cycle of bedbugs they must shed skins between blood meals to develop. This can be a good indication of how long an infestation is present.
- Faecal traces – as bedbugs must defecate after a blood meal and often just before entering a refugia these are the most indicative sign of their presence and can be a good indicator of their locations.

The following are considered to be non-confirming signs:

- Bites – this is because not everyone initially responds to the bites of bedbugs, this fact explains why a hotel can have an undetected infestation for so long and why screening for early detection is such an essential step in an integrated bedbug management systems.
- Blood spots on sheets – an equally variable sign not only due to the different types of blood spots but also due to the fact that no everyone continues to bleed from the puncture wound.

Prevention

In the case of domestic settings prevention can only be achieved through avoidance of this pest. As a pest of exposure bedbugs must always be brought into the home

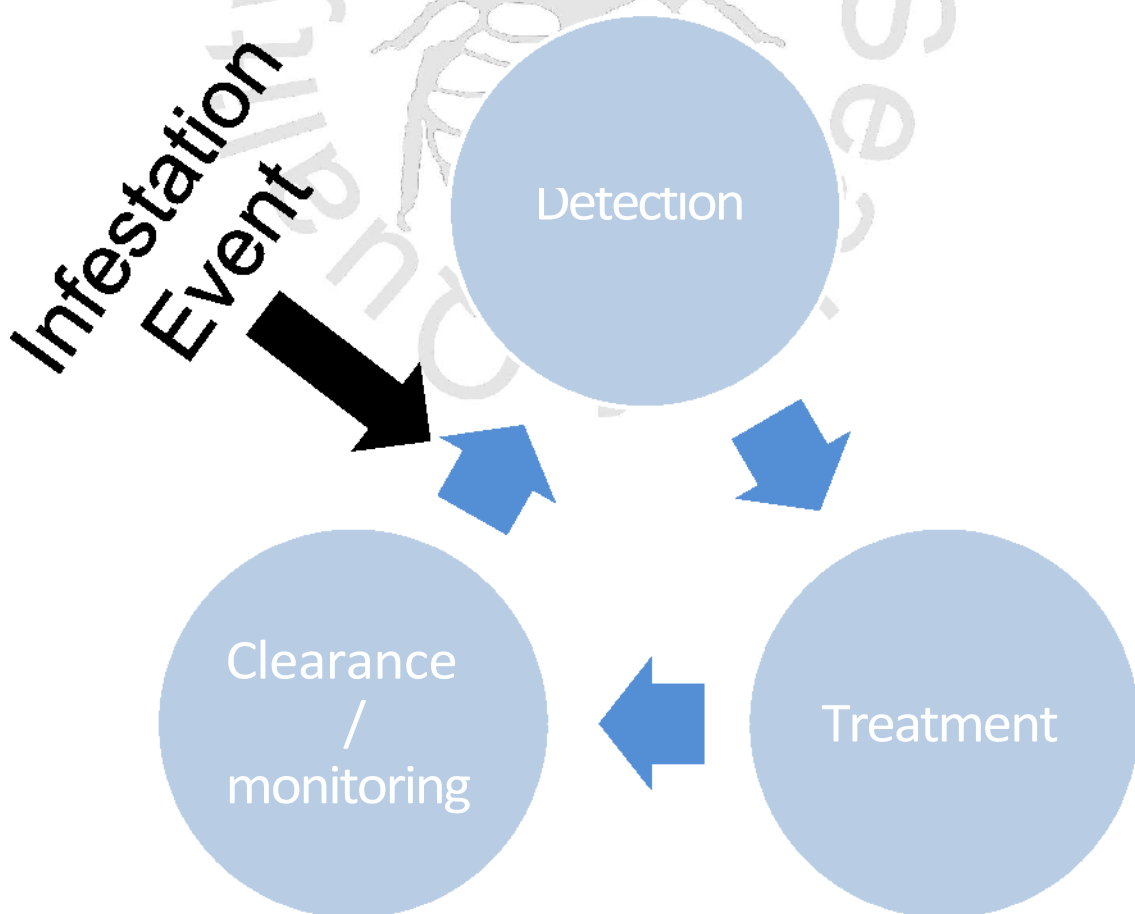
through an introduction event or increasingly through adjoining walls from a neighbouring property. Sources of bedbugs in domestic settings have been traced back to:

- Work locations
- Hotel stays
- Hospital stays
- Public transport
- Second hand items
- Delivered with new items

Domestic prevention is only possible through public education and increased awareness of the need for early detection and avoidance. Although this is a slow process in today's fast media culture it was the only solution in the past and remains an extensively unmet need.

The only truly preventative technology to assist people in home presentation is the PackTite decontamination system (www.PackTite.com) which enables people to heat treat items before they are brought into the home. Although not globally available at present it is a valuable aid to anyone facing a bedbug situation.

The infestation cycle



The infestation cycle of bedbugs encompasses three distinct phases:

- Detection – the first stage of the control cycle is to identify and confirm the issue. Although there are multiple approaches to detection the key to an effective system is cost and operational efficiency. Regardless of what method is used the aim should always be to detect the infestation within the first 30 days when it is relatively contained and less likely to have spread through to other rooms.
- Treatment – although this is the part of the cycle which we tend to focus on the most it is in fact clearly the wrong stage for initial focus. The extent of an infestation and therefore the appropriate methods to apply is very much dictated by the extent and duration of the infestation.
- Clearance – in essence a control stage to ensure that the treatment has been effective and that all bedbugs have been eradicated.

The infestation event cannot be modelled or predicted, the only control we can exercise over it is to reduce the period of time between the infestation event and the detection and subsequent control phases of an infestation. The shorter the time between the infestation event and the detection of an infestation the faster the issue can be resolved.

For further information on bedbugs please see the following web resources:

www.Bed-Bugs.co.uk
www.BedBugBeware.com
www.BedBugger.com

Principles of pre infestation optimisation

Given that if bedbugs enter a property they ideally will remain close to a source of regular food (human blood) the foundation principle of a ProActive approach to bedbugs is to limit those locations through organisation and optimisation. If you don't give bedbugs many options for setting up home they will live where you direct them rather than wherever they can or wherever they choose.

Optimising your home environment can greatly limit the impact of an infestation reducing the duration and disruption caused by an infestation.

The reality of this approach is that it is often easiest to do from the start of a new bed so that each component can be sealed and optimised before the furniture is assembled. Ideally furniture manufacturers will adopt this approach and provide a more optimised product at the point of sale.

Optimisation is much easier to achieve with certain types of furniture and in particular certain materials, the easiest to work with are:

- Simple light coloured wooden beds without any surface treatment

- Simple wooden beds with a light coloured surface

treatment The least optimal types of beds to work with are:

- Metal frames beds
- Box section or divan beds
- Wooden surfaces that are either dark wood or treated to be dark

Above all metal framed beds should be avoided as they seem to automatically cause bedbugs to diffuse in domestic settings, although this is contrary to much of the early internet information on bedbugs this recommendation is made following more years of dedicated field observations of bedbugs than most people could endure in a lifetime.

If box spring or divan beds cannot be avoided then they should be encased. If the property is bedbug free then there is no need for a specialist sealing encasement although it is important to use an encasement that is a correct fit top reduce creating new harbourages.

Passive monitoring

In essence as part of this procedure the passive monitor acts as the optimal home for bedbugs so that if they are brought into the home they locate in specific area. This works in the same way as placing a bird box in your garden in a location away from disturbance but also in a location where you can see any birds that use the nest. In the case of this technology the bedbugs are induced to defecate on the detection skirt and thus are easily detectable.

In an optimised environment removing and replacing the passive monitor with a thorough inspection and deep cleanse of the area to remove any remaining bedbugs can resolve a light infestation.

When we talk about passive monitors we specifically refer to products covered by patents GB2470307 and GB2463953 current available as passive bedbug monitors from Bed Bugs Limited and BB Alert Passive by MidMos solutions.

Tools and resources

Like many aspects of work involving bedbugs planning and advanced preparation is essential to achieving results.

Essentials

- High gloss varnish or gloss paint
- Clear adhesive tape of various widths
- Filler such as general purpose wood or material appropriate filler
- Passive bedbug monitor to offer optimal refugia for any bedbugs that are present

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- All tools necessary to dismantle the bed if already constructed or to assemble the bed if it is optimised and then built

Non essentials but may be beneficial

- Thin foam rubber sheeting or latex sheeting
- Isolation devices such as bed moats (www.bedmoat.com) for if an infestation occurs

Example

The images below were supplied based on a normal US home and are used to illustrate the principles. This is not a definitive guide for all forms of bed but teaches the principles of how to optimise an area. By understanding the example you should be able to apply the principles to your individual circumstance.



Traditional wooden bunk beds, the white colour is already optimal for ease of detection but closer inspection shows that there are a number of potential refugia which can be easily engineered out of the area.

Although this bed is shown with isolation devices such as the bedbug moat (www.bedmoat.com) they are not an essential part of this strategy. There is some thought that making it harder for anything to get into the bed and thus the optimised refugia can cause bedbugs to relocate into harder to reach areas people generally seek to find ways to reduce the risk of bites. I would personally only recommend this

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approach with people doing self-treatment or with a strong reaction to bites. The long term use of bed isolation is not recommended due to the need to maintain the talc coating every two weeks.



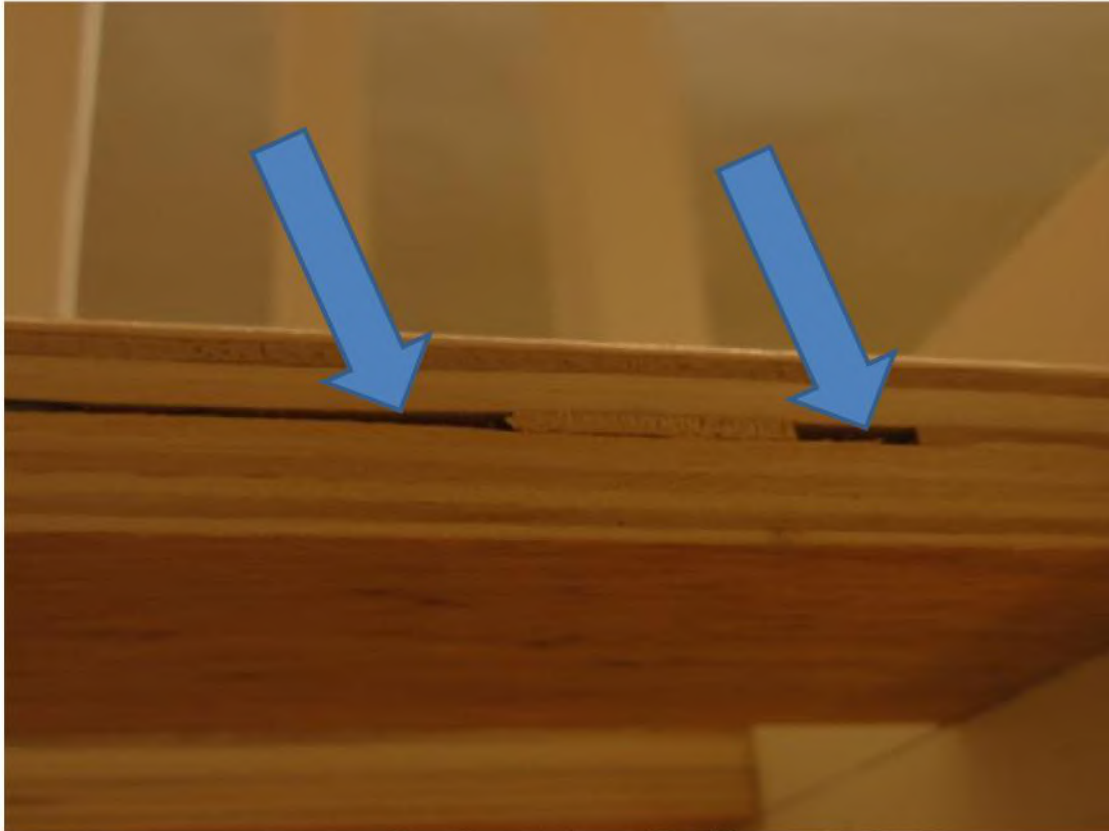
End on view of the same bed. Optimisation of these surfaces is covered in more details following the close-up images.



Top down view of the frame of the bed. All wooden slats **MUST** be varnished to a high gloss or painted in gloss paint apart from the last slat at the head end of the bed where the passive is installed.

In this situation the installation location for the passive monitor shown in red is close to the side of the bed next to wall. We refer to this as the “dark” side of the bed as it is the most likely side to become home for any bedbugs.

If the bed were positioned so that the head end of the bed was against the wall then the middle of the head slat would be optimal.



Any cracks or splits in the wood and in particular the slats **MUST** be sealed or filled with an appropriate filler to prevent them becoming harbourage points. If the part of the bed needs to remain flexible and filler would eventually degrade applying a tape covering will also suffice.

My personal recommendation is always clear tape for the area can still be inspected if you wanted and that any lifts or bubbles in the tape do not hide anything from sight.



Large gaps and crevices can be reduced either with filler or through the fitting of packing cut from the foam rubber sheeting or latex sheeting. The use of sealants should be avoided as with time they shrink and may in future open up a potential harbourage site. For the same reason they are not suitable for sealing with tape.



All screw and bolt holes **MUST** be covered over with clear tape to prevent them being harbourage points. This includes all screw holes on the top of the slats that secure them to the frame of the bed.

Again filler should not be used as it makes dismantling the bed should it be needed a lot harder. Although you may assume that once constructed you will never want to take the bed apart again should a treatment be needed being able to dismantle the frame back to its component parts can be extremely useful.



Screw holes are often also present on the underside of the side runners which support the slats. They **MUST** also be covered with tape or filled with filler. As these screws are not normally removed to dismantle the bed they can be permanently sealed.

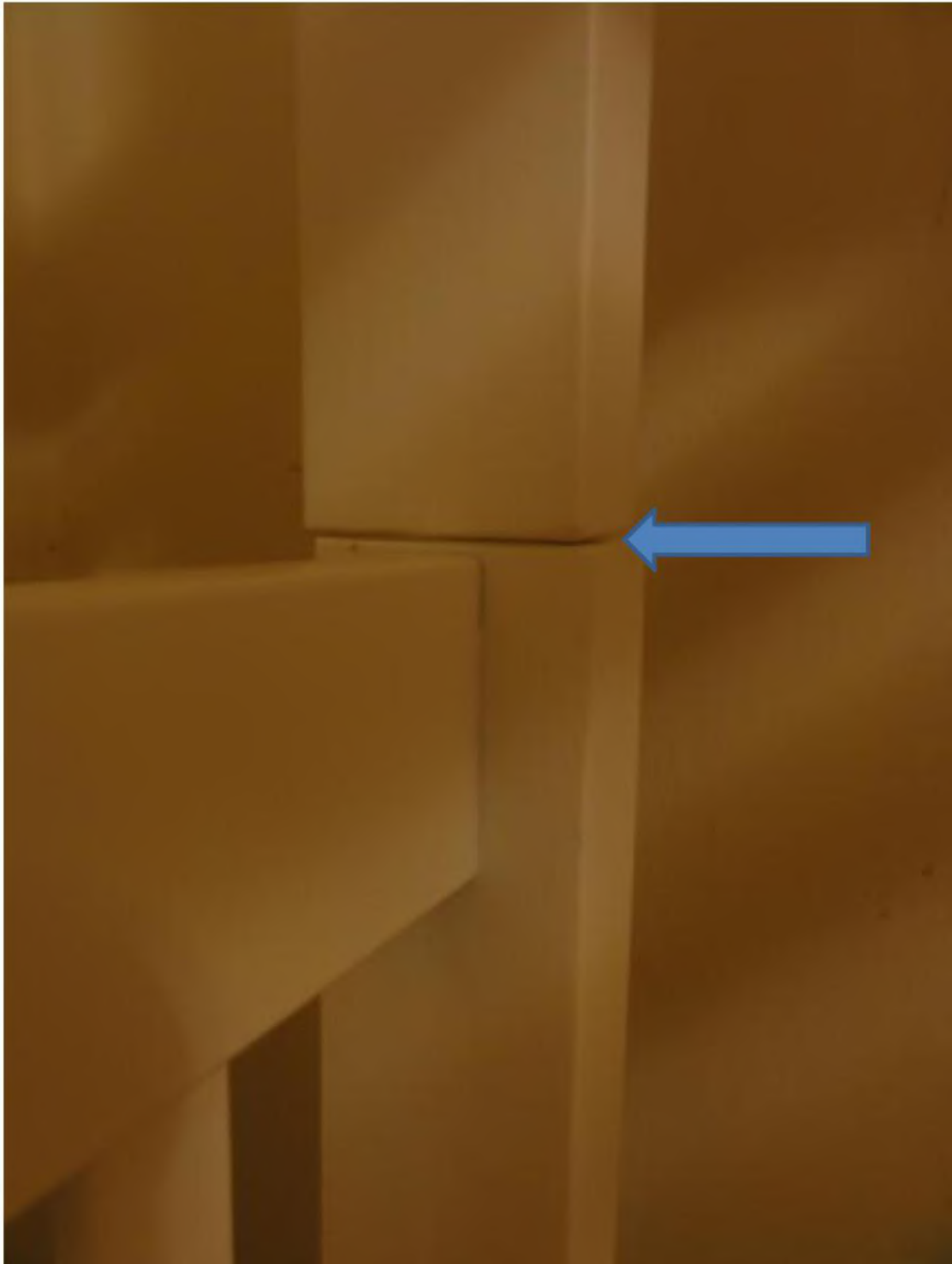


Screw and bolt holes on the outside of the frame on surfaces which face into the room as low risk of infestation and do not need to be covered unless they are usually obscured such as by hanging clothes or items over them.

They are best sealed with clear tape to ensure that they can be easily inspected.



Screw and bolt holes which are normally either against a wall or on the “darker” side of the bed **MUST** be sealed or covered as a matter of course. These areas are more likely to become harbourage sites than ones that face into an open room.



Joints between two pieces of wood such as this are less likely to become harbourage points but can also be easily protected by cutting an appropriately sized piece of latex or foam to fill the gap.

As long as a model harbourage is provided in the form of a passive monitor any bedbugs are more likely to locate there than in a more hostile location like this.

Acknowledgements

I would like to thank the person who submitted these images to me in order to be able to create this document. Rather than use an artificial set up I prefer to work with real life situations and images. Their willingness to share has resulted in this document which I hope will in turn help others.

I would also like to thank the person who made that possible “nobugsonme” the host of BedBugger.com which has served for many years to be the homes of a disparate band of bedbug professionals, survivors and sufferers sharing resources and helping people with advice and support.

I also would like to thank Richard Naylor at Sheffield University for permission to use one of his amazing pictures in this document.

Disclosure

In accordance with the FTC and good business ethics we felt it was important to ensure full disclosure of the fact that the author of this document is also the inventor of the Passive Monitoring technology mentioned as part of this document.

No other companies mentioned in this document have paid for their inclusion or offered any form of financial remuneration to be in this document, they are included on their own merits and value.