



Byjim Holland, CR

# Remediation of Sewage Contaminated Crawlspace

Sewage damage remediation requires additional training beyond what is typically provided to restoration technicians. Performing these services becomes more complex when the cleanup involves a crawlspace. Safety should always be the first consideration, after which issues of accessibility, inspection, remediation, sampling and documentation must be considered. By addressing these issues, you can protect the health and safety of workers and occupants, while controlling costs and **cleanup time**.

## Health & Safety First

Those who professionally remediate sewage backflows are at a higher risk for adverse health effects from infectious agents, potent allergens, noxious gases, vapors, fumes, endotoxins and mycotoxins. Recent research has shown that workers with routine sewage exposures exhibit respiratory dysfunction (Zuskin et. al., 1993; Richardson, 1995), fatigue and headache (Melbostad et. al., 1994), infection (Schlosser et. al., 1995), and increased incidences of cancers (Friis et. al., 1993). Thus the need for adequate training, immunization, and the use of personal protective equipment to protect employees against all three routes of exposure: dermal, inhalation and ingestion.

Employees who provide sewage contamination services can be exposed to bacterial infections from skin and eye contact. Infections to hands and feet can result from not wearing protective gloves and boots. Harmful bacteria can enter under fingernails, through skin rashes, cuts, sores and puncture wounds. Respiratory illness from the aerosolization of sewage dust, airborne endotoxins, allergens and other infec-

tious agents can develop from not wearing a respirator. Stomach cramps, dysentery, and other intestinal disorders can result from hand-to-mouth contact and poor personal hygiene.

Substructure remediation should always begin by determining and eliminating the cause of the water intrusion. In some cases a plumber may be required to make that determination. Use of a plumber may require that the substructure area be extracted first.

After determining the cause of the water intrusion, it may be necessary to determine the financial responsibility for the cleanup. If the cause is a result of blockage in the sanitary sewer main line, then the cost of remediation may be the responsibility of the public entity or utility district that is required to maintain the sewer system. Otherwise it may be the responsibility of the building owner or their insurance carrier.

As part of the initial investigation, it is also helpful to know if the sewage backflow was an acute or chronic problem. An acute problem would generally be a single event of relatively short duration. Even though the water intrusion may be acute, the amount of flow into the crawlspace may be significant. It is therefore important to determine the size of the area affected. Chronic problems are generally repeated events or an ongoing event. It is reasonable to assume that a chronic problem will require a greater degree of response. Black water that sits in a crawlspace can penetrate into the soil, making it more difficult to address the contamination. The extended period of time will also result in an amplification of the bacteria present and in the development of mold.

In the case of a black water intrusion, a chronic water intrusion or an

acute clean water intrusion that sits for an extended period of time, it may be necessary to shut off the air handling systems to the affected area(s) of the building. Cover the supply and return vents to prevent contamination and control airflow due to changes in building pressurization.

## Accessibility Issues

Before entering a crawlspace, the accessibility issues need to be addressed. Keep in mind that a crawlspace is a confined space. A confined space is defined as an area that:

1. Is not designed for continuous employee occupancy; and
2. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
3. Has limited or restricted means of entry or exit.

In some cases a confined space is determined to be a permit required confined space. A permit required confined space is a space that meets all of the above conditions and has one or more of the following hazards:

1. Atmospheric hazards, which are or potentially can be asphyxiating, toxic, flammable or explosive.
2. Engulfment hazards, which exist when someone is trapped or enveloped by a liquid or dry, bulk material such as grains, soil or powdered cement.
3. Configuration hazards, wherein the size or shape of the space can trap an employee or make escape or rescue difficult.
4. A confined space that contains any other recognized serious safety or health hazard.

Check with your local governmental

agency to determine the applicability of the Confined Space Regulation. In the absence of any requirement to comply with the Confined Space Regulation, following this regulation makes good sense.

Crawlspaces are not sanitary environments, with or without the presence of a black water intrusion. An entrant should wear a full-face air-purifying respirator to protect against inhaling dust as well as microorganisms. The respirator should be equipped with a combined HEPA and organic vapor cartridge. In certain situations, it may be advisable to use a powered air purifying or supplied air respiratory protection system. In wet environments, Tyvek type suits may not be adequate to protect against exposure. A more durable and impenetrable body covering such as PVC, rubber or polyethylene-coated material is advisable. Protective clothing should include an attached hood. Additionally, rubber boots and gloves are required. Other safety issues for entrants include, but are not limited to: electrical shock, puncture wounds, or bites from insects, rodents, or other small animals.

Other access considerations should include whether the crawlspace access is located in the interior of the building or on the exterior of the building. When entering from the interior of the building, it is necessary to insure that there is a negative pressure relationship established between the crawlspace and the living/working area prior to opening the access door. This may be accomplished by drawing air out of the crawlspace at a foundation vent. Additionally, the tracking of contaminated material out of the crawlspace into the living area may preclude the use of interior access, unless a decontamination chamber is erected in the building interior. All interior surfaces need to be protected against contamination.

All entrances and exits to and from the crawlspace should bear the appropriate signage indicating the nature of the hazard and that access is restricted to trained personnel wearing appropriate personal protective equipment.

### Crawlspace inspection

Once the accessibility issues have been dealt with, the crawlspace inspection can begin. The inspection of the crawlspace needs to first address the safety of the inspector, secondly look for other safety hazards that affect workers, and lastly determine the remediation needs. Items that may be useful in the inspection of a crawlspace may include a flashlight, drop lights with GFCI cords, GFCI extension cords, a thermal hygrometer and other moisture meters, plastic sheeting and drop cloths.

Upon entering the crawlspace and depending on the types of animal life indigenous to the geographic area, look for small animals such as raccoons, pos-



sums, skunks and various other rodents, bees or wasp nests, spiders, scorpions, snakes, etc. If any animal life is encountered that poses a potential threat to health or life, exit the space and have an experienced animal or pest control firm solve the problem prior to re-entry.

Upon re-entry into the crawlspace, after the space is free of animals and pests, begin to look for other potential hazards such as exposed electrical wiring, nails that protrude from the structure, broken glass or any other item that may result in a puncture wound.

If any other safety hazards are found, it will be necessary to either immediately

correct the problem or correct the problem prior to the entry of any remediation crew member, depending on the nature of the safety hazard.

Conditions in the crawlspace that may impact the remediation progress include, but are not limited to:

- 1) The amount of water intrusion.
- 2) The height of the crawlspace work area.
- 3) The size of the crawlspace access opening.
- 4) The presence of HVAC duct work.
- 5) The presence of either a plastic moisture barrier or a low-density-fill concrete cap over the soil, sometimes referred to as "rat proofing."
- 6) The presence of pea gravel or other ground cover.

- 7) The presence of debris.

The inspection also should include a determination of the moisture content of structural materials, including ductwork, insulation and wood structural members. It may be necessary to remove ductwork that is either saturated with clean water, contaminated with unsanitary water or that may become contaminated during the remediation process. Some supply vents and ductwork may be wrapped with asbestos, requiring the utilization of an asbestos abatement firm. If the insulation is contaminated with unsanitary water or may become contaminated during the remediation process, it must be replaced.

### Remediation. Considerations

In unsanitary flooding situations, remove all standing water, organic waste and debris from the crawlspace using wet vacuuming or other appropriate techniques. If a ground vapor barrier was previously installed, do not punch holes in the plastic vapor barrier to allow water to be absorbed into the ground soil. After extraction, remove any plastic vapor barrier that may harbor organic debris or inhibit evaporation of water from saturated soil.

In any unsanitary water intrusion, chronic water intrusion or clean water intrusion that has sat for a number of

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days, the drying of the crawlspace must be accomplished by creating and maintaining a negative pressure relationship between the crawlspace and the work or living area. Generally, this can be accomplished by pulling more air out of the crawlspace than is being allowed into the crawlspace. The pressure relationship needs to be monitored on an ongoing basis throughout the remediation. Take care to avoid exhausting the air from drying and air handling equipment to an area where it may adversely affect surrounding buildings and people.

The structural members of the crawlspace can be treated with a biocide to kill bacterial contaminants. If mold growth is present, then physical removal of the mold from the structural materials without the use of biocides is recommended. In either case, the air space in the crawlspace should be HEPA filtered and the work areas should be HEPA vacuumed regularly during the work process.

Next, it must be determined which soil treatment method is most appropriate. Most biocides that are safe for use in these environments are inactivated by organic material and therefore, may have little or no value. The application of lye or lime presents other short and long term adverse exposure issues that may preclude the use of these products. Other soil treatment alternatives include, but are not limited to:

1. Soil excavation and/or replacement of top soil.
2. The application of a mild detergent to reduce microorganism concentration in the soil.
3. The installation of 10-mil polyethylene sheeting with no vent system.
4. The installation of a Was mat collection system or a perforated pipe with a passive vent system to the outside covered with 10-mil polyethylene sheeting.
5. The installation of a gas mat collection system or a perforated pipe with an active vent system to the outside covered with 10-mil polyethylene sheeting.
6. The installation of a gas mat collection system or a perforated pipe with an active vent system to the outside covered with a low-density-fill concrete cap.

Employees exiting the work space need to perform a rough cleaning of the exterior of their PPE either by HEPA vacuuming, damp wiping or rinsing prior to removal in a location and manner that will prevent cross contamination of surrounding areas. All reusable equipment such as boots, respirators and protective clothing then must be thoroughly cleaned and disinfected. All disposable equipment such as gloves, disposable protective clothing and respirator cartridges should be placed in six-mil polyethylene bags for disposal.

Any contaminated waste, debris or materials should be disposed of in an appropriate dumpsite following all local, state and federal regulations. In some geographic areas the transportation and dumping of contaminated materials may require special permits and/or fees.

### Environmental Sampling and Documentation

After remediation and prior to removing any containment or air handling units, it is advisable to have an environmental consultant test for any remaining contamination. Usually a report will provide the sampling procedures, sampling results, an explanation of the data and recommendations for any further remediation if necessary.

in addition to other documentation, detailed field reports should be kept throughout the project. These reports could include, but would not be limited to: daily time logs with a description of completed daily activities, equipment usage logs, moisture and RH readings, pressurization or containment logs and air handling equipment filter replacement logs.

if the soil treatment option was the installation of a vented system covered with 10-mil plastic, it would also allow for the future environmental monitoring of the soil. If it is determined that the soil has returned to a normal condition, the vent system can then be removed. The advantage of removing the vent system is that there is then no lingering evidence of a sewage intrusion. The budding owner may still be required to disclose the previous condition.

Not all crawlspace remediation projects are identical. The ideas presented here are general procedures for you to consider. Circumstance and local or

making decisions. Consult with environmental and safety professionals if you have questions.

Always remember: "Safety First" and "E. coli happens."

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*Jim Holland, CR, has been actively engaged in the cleaning and restoration industry for over 25 years. He is an ASCR Certified Restorer, and currently serves as a member of the Water Loss Institute Advisory Committee, the edit committee for the IICRC S500-94 Water Damage Standard and as Chairman for the IICRC Health and Safety Task Force. He is a nationally recognized instructor, consultant and author.*

regional regulations may require you to modify or deviate from these suggestions. In all cases you need to use best professional judgement in