



# Urban Flooding Threats to Worker Safety and Health

## National Clearinghouse for Worker Safety and Training

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November 14, 2022

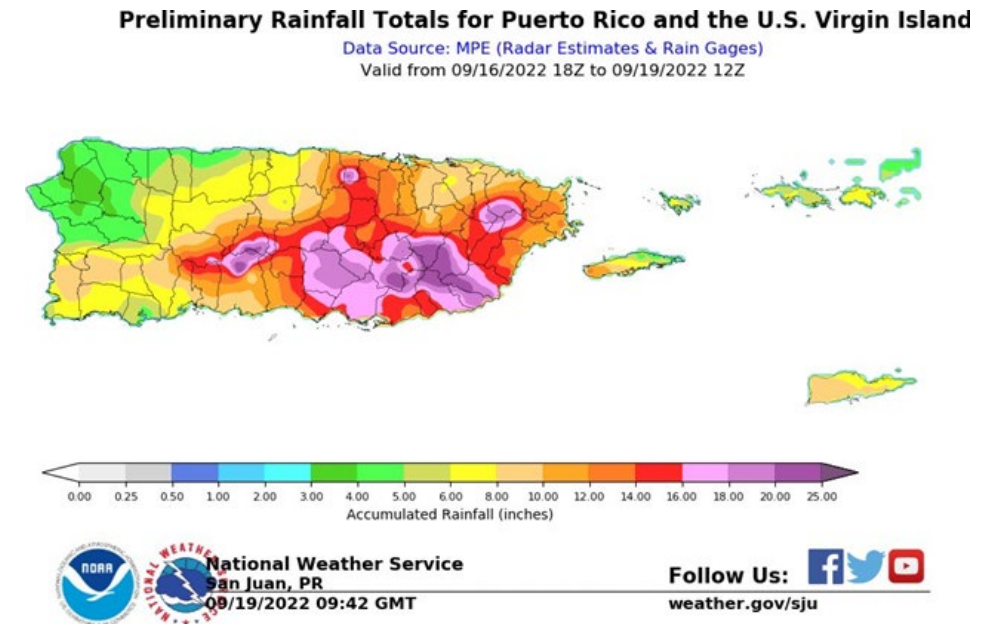


# Objective

- To determine if the built/urban environment poses any unique health hazards during clean-up activities following rapid flooding due to tidal surge or precipitation
- The focus was on the post-flooding clean up and not the immediate life-saving response activities conducted by first responders

## Severe Storms + Increased Impervious Spaces = Flooding

- Characteristics of the Built/Urban Environment
  - Mixed residential, commercial, industrial zoning
  - Antiquated utility infrastructure
  - Usual standard to handle surface runoff—1-1.5 inches of rain/hour
  - Many impacted areas are outside the FEMA flood zones
  - Multiple stories above and below ground level
  - Opportunities for mixing of many types of chemical and biological contaminants in standing water
  - Mixing of pedestrian, road, construction traffic
  - Resident inhabitants represent full spectrum of demographics
  - Recovery workers preparation ranges widely



## WTP Urban Flooding: Methodology

- Definitions
- Literature search
  - Peer reviewed
  - Grey literature/After Action Reports/Media Reports
- Targeted interviews
  - NIEHS grantees, subject matter experts
- Stakeholder meeting
  - Subject matter experts, federal agencies

## Findings Consistent with Current Knowledge of Floods

- Little studies on the health hazards to workers
- No unique health hazards were noted
  - Chemical/biological hazards
  - Trauma hazards: penetrating/blunt trauma, falls, hypo/hyperthermia, electrocution



## Findings Consistent with Current Knowledge of Floods (cont.)

- What was unique is the potential scale and concentration of hazards and the high density of mixed hazards
  - Communication and visual challenges contributed to the risk
- Other findings
  - Training and protective equipment for working in the urban flooded environment was mixed, ranging from very good to inadequate
  - Areas of repeat flooding were generally felt to be lower economic communities with limited access to insurance, healthcare, and resources to repair homes to code
    - Were often subject to predatory contractors
    - Self repair was often not to code and done without adequate PPE and training





## Urban Flooding and Worker Health Effects

Prepared by MDB, Inc. for the NEIHS Worker Training Program | May 2022

Table 3. Urban Flooding Worker Risk Stratification\*

	Understanding of work site risks	Knowledge of health effects	Availability of PPE	Availability of Job Training	Access to health care upon injury	Overall health risk
<b>Homeowner</b>	Low	Low	Low-must purchase	Minimal	None—only private health insurance	<b>HIGH</b>
<b>Day laborer/immigrant worker</b>	Low	Low	Low-often times must purchase	Minimal to moderate-mostly just-in-time, on-site minimal	None – only private insurance	<b>HIGH</b>
<b>Unpaid volunteer under small NGO or by self</b>	Low	Low	Low- often times must purchase	Moderate-mostly just-in-time, on-site minimal	None – only private insurance	<b>HIGH</b>
<b>Unpaid volunteer under large NGOs</b>		Some NGOs/ CBOs provide	Moderate - Large NGOs provide	Moderate - Large NGOs provide CBOs provide	None – only private insurance	<b>MODERATE</b>
<b>Paid laborer</b>		Some contractors provide basics	Many contractors provide	Many contractors provide basics	May receive health benefits from work or able to apply for workers' compensation	<b>MODERATE</b>
<b>Paid professional</b>		Good	Provided by employer	Advance training and JIT	Employer/union provided health benefits or via workers comp	<b>LOW TO MODERATE</b>

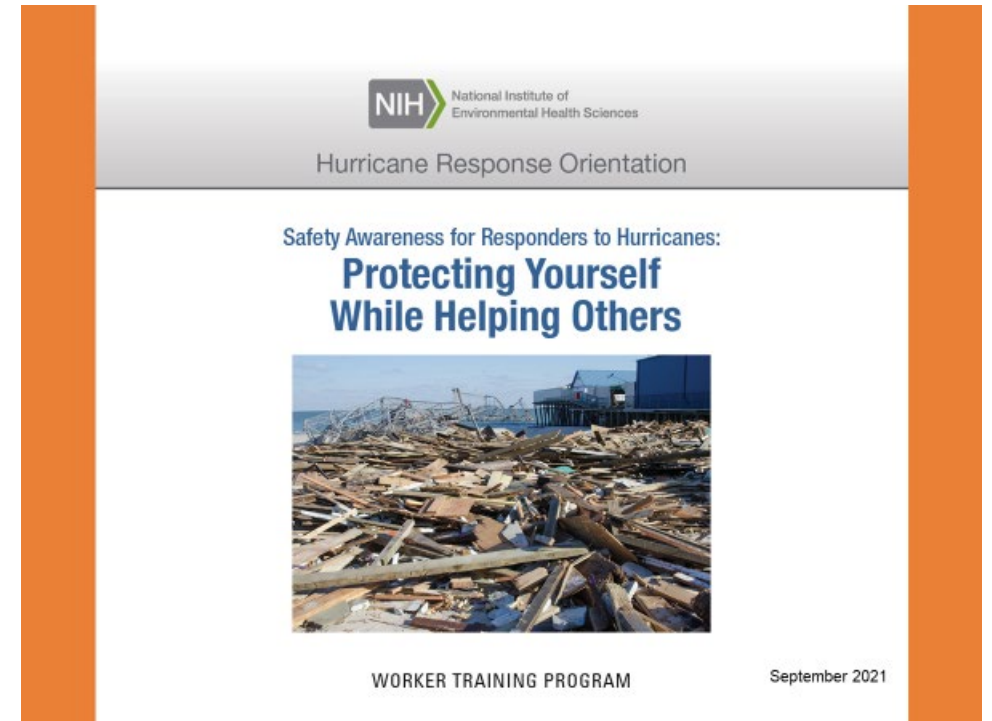
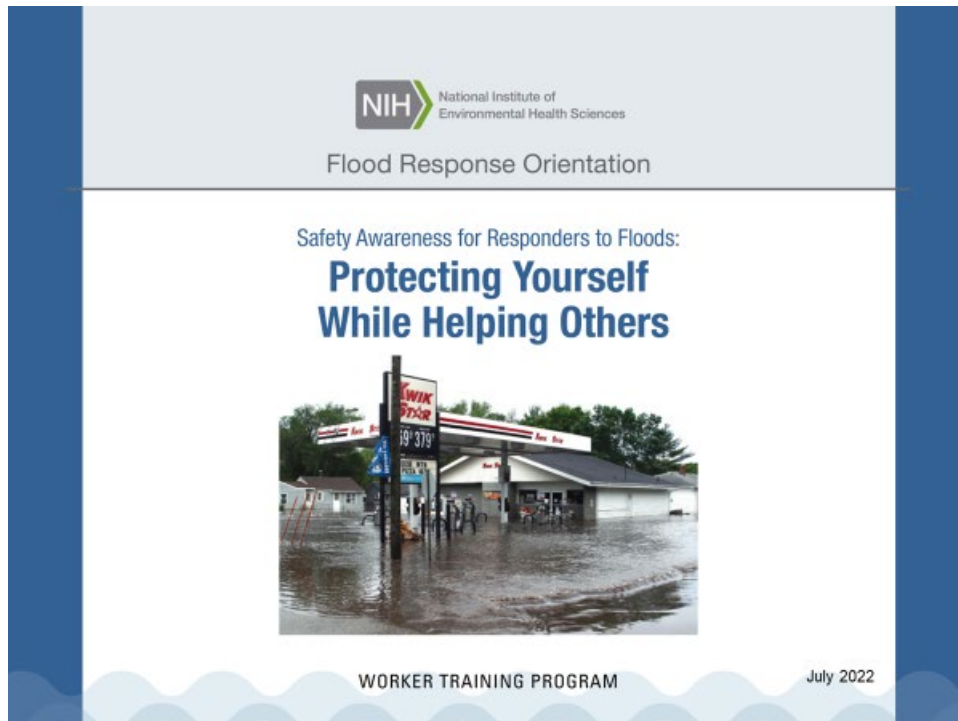
\* Exceptions may occur.

## Going Forward

- Recognition that the threats are the same, but the health risks may be greater
- Better empower vulnerable communities
- Identify At Risk Communities
- Provide information for mitigation, response, and recovery
- Improve training of workers to include appropriate PPE
- Improve coordination of:
  - Federal to Federal
  - Federal to State/Tribe/Territory
  - STT to Local
  - Local to Local



# Inclusion of Urban Flooding into Hurricane and Flooding Training Booklets





# Urban Flooding Resources

## **National Clearinghouse for Worker Safety and Training**

Nicholas V. Cagliuso, Sr., PhD, MPH

November 14, 2022

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## National Clearinghouse for Worker Safety and Health Training

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The National Clearinghouse for Worker Safety and Health Training is a national resource for hazardous waste worker curricula, technical reports, and weekly news on hazardous materials, waste operations, and emergency response. Funded by the NIEHS Worker Training Program (WTP), the National Clearinghouse provides technical assistance to WTP staff, program awardees, and the general public.

For more information on the resources available from the National Clearinghouse, please view our [Training Resources Fact Sheet](#) 📄 (1MB).

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**What's New**

[Urban Flooding and Worker Health Effects](#) 📄(217KB) **NEW**  
This report details the unique features of floods in the urban environment and the potential health effects for workers, homeowners, and others who perform cleanup and recovery activities.

[Urban Flooding Fact Sheet](#) 📄(432KB) **NEW**  
This fact sheet describes the wide variety of hazards that workers and homeowners should be aware of during or after an urban flood. It also provides tips to help workers and homeowners avoid and prevent exposure to structural hazards, infectious agents, and toxic chemicals.

[Inundaciones Urbanas: Peligros y consejos de prevención](#) 📄(395KB) **NEW**  
Este folleto describe la amplia variedad de peligros que los trabajadores y dueños de casa deben tener en cuenta durante o después de una inundación urbana. También proporciona consejos para ayudar a los trabajadores y dueños de casa a evitar y prevenir la exposición a peligros estructurales, agentes infecciosos y químicos tóxicos.

For other related resources, visit the [Hurricanes and Floods webpage](#).



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## Flood Response Orientation

Safety Awareness for Responders to Floods:

# Protecting Yourself While Helping Others



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July 2022





## Flood Response Orientation



## Urban Flooding Supplement

## Urban Flooding Is Increasing

Increased frequency of **severe weather**, with many severe storms exceeding an hourly rate of over 2-3 inches per hour.

Expansion of the **built environment** has eliminated or reduced much of the local natural capacity to absorb precipitation resulting in excess run-off.



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## Flood Response Orientation



### Urban Flooding Supplement

## Unique Features of Urban Floods

- **Concentration:** Urban flooding may be concentrated in smaller areas than other types of floods.
- **Combination of hazards:** Chemical and biological hazards in urban flood waters may contain higher concentrations of infectious agents, chemical hazards, or both.
- **Mixed-use:** Urban areas that have industrial, commercial, and residential uses all within one area or even in one building.
- **Above and below ground infrastructure:** The impacted areas contain buildings that are taller and have multi-level basements, increasing the risk of traumatic injury.
- **Traffic:** There is a greater likelihood of mixed pedestrian, road, and work traffic in confined spaces, making the risk of vehicle-vehicle and vehicle-pedestrian collisions higher.



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### Urban Flooding Supplement

## Urban Flooding and Equity Considerations

Urban Flooding exposes long-standing equity and disparity factors that make communities more susceptible to the health hazards and risks from the flood waters.

### Be Empathetic and Understanding

Community members have often experienced repeated floods which resulting in financial strains and mental health impacts such as anxiety, stress, and depression.

### Prepare for Additional Risk

Remediation work on homes that have been repeatedly flooded may have aging infrastructure, exposed hazards, and previous repairs that may not have been done to local building codes.

### Consider Worsening Hazards

Delays in obtaining assistance or hiring of contractors resulting in worsening of the damages such as mold. There may be greater risk to remediation workers and/or homeowners.

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## Flood Response Orientation

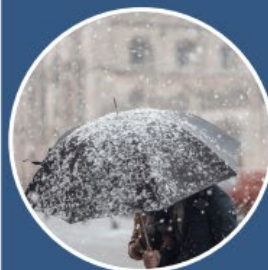
### Urban Flooding Supplement

## Urban Flooding Hazards



### Trauma

- Falls
- Lacerations, punctures, contusions
- Burns
- Electrocuting
- Animal/insect bites/envenomation



### Environmental

- Hypothermia
- Hyperthermia



### Biological

- Sewage from backflow of aged sewage systems
- Mold



### Chemical

- Industrial chemicals
- Petroleum products
- Inhaled hazardous particulate materials, e.g. asbestos
- Carbon monoxide



### Mental Health

- Anxiety, stress from working in a complex high-pressure, hazardous environment

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## Worker Safety Guidance

- **Be vigilant.** There are many unseen hazards underwater, in the water, and in the air.
- **Get trained.** Take job training as it is available, including any on-site just-in-time training. Pay attention to on-site safety training and know the hazards.
- **Know and follow the employer's safety policies and procedures.** You have a responsibility to use the appropriate PPE and follow all safety procedures. Report unsafe conditions and all injuries, as delays in reporting safety issues may result in a preventable injury or death.

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## Worker Safety Guidance (continued)

- **Properly use the recommended personal protective equipment.**
  - Respiratory protection, gloves, outer garments, shoes, eye protection, waders when working in floodwater
  - Vaccinate for tetanus, hepatitis (if concerned about exposure to body fluids, feces), and influenza. Do this in advance as it takes weeks to reach full immunity
- **Use extreme caution when operating vehicles, chain saws and working from heights.**
  - Vehicular collisions, lacerations from chain saws, and falls are among the most traumatic types of injuries, causing severe lacerations, fractures, and permanent injuries.
- **When working in basements and below ground, make sure there are functional communications, adequate lighting, proper ventilation, and the power lines have been secured prior to entry.**
  - Hazards found below ground include live electric wires, poor visibility resulting in falls, blunt and trauma, and carbon monoxide poisoning when using power equipment in poorly ventilated basements
- **Follow the guidance found elsewhere in this booklet.**

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Flood Response Orientation



Urban Flooding Supplement

## Worker Safety Guidance (continued)



**Understand the hazards of the flooded urban worksite are more concentrated and less tolerant of errors.**

- Never enter a flooded building until deemed safe for entry.
- Treat all wires as being energized.
- Never operate gas powered equipment indoors.
- Make sure there is adequate ventilation in the workspace, especially indoors and below ground areas.
- Never enter moving flood water.

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## Urban Flooding Resources

*In English:*

- [Urban Flooding and Worker Health Effects](#)  (217KB) **NEW**
- [Urban Flooding Fact Sheet](#)  (432KB) **NEW**

*En Español:*

- [Inundaciones Urbanas: Peligros y consejos de prevención](#)  (395KB) **NEW**



National Institute of  
Environmental Health Sciences  
Worker Training ProgramURBAN FLOODING:  
Hazards and Tips for PreventionThis fact sheet is intended for  
workers, homeowners and business owners  
impacted by flooding in urban areas.

Flooding in urban areas has become more common due to the rising number of hurricanes and other extreme weather events. These flooding events are linked to high rates of rainfall that overwhelm urban systems' capacity for excess water.

Flooding events can be extremely dangerous, especially fast-moving water that rapidly fills streets, homes, and buildings before people can safely evacuate. Some urban communities experience repeated flooding events which can be stressful for homeowners due to the financial strain, emotional stress, and hardships of temporarily living in a damaged home.

Cleanup and repairs after flooding can expose people to a variety of hazards, all of which can be avoided. This fact sheet provides some tips to help workers and homeowners protect themselves during or after urban flooding events.



## What health hazards should I be aware of during or after a flood?

**Structural hazards:**

- **Trauma** from tripping, falling, stepping on sharp objects, and using chainsaws. **Broken bones, severe head injuries, and lacerations** may be caused by falling debris from unstable structures, nails, working on ladders, or improper use of equipment.
- **Burns and electrocution** from live electrical wires. The burns and damage from electricity can cause severe tissue damage and even death.

**Harmful exposures:**

- **Carbon monoxide** in the air when using gas powered equipment indoors, such as power washers, without good ventilation. Carbon monoxide poisoning can lead to serious medical problems and death.
- **Infectious agents** carried in contaminated floodwater. Sewage backups can contaminate floodwaters which collect in structures below the ground. This water may contact open wounds, causing skin infections, or be swallowed accidentally, causing vomiting or diarrhea.
- **Mold** can lead to or worsen lung health issues like asthma and chronic obstructive pulmonary disease. Chronic, unresolved moisture can lead to mold growth on walls and furniture in flooded spaces. Mold spores can spread in the air and be breathed in when cleaning spaces.
- **Toxic chemicals**, like gasoline, oil, or industrial toxins can cause skin irritation or other problems if swallowed.



## What can be done to prevent these hazards?

**Tips to avoid structural hazards and harmful exposures:**

- Never enter moving floodwaters.
- Never operate gas powered equipment indoors.
- Never operate a generator indoors or near open windows or doors.
- Avoid exposure to floodwaters.
  - Wash exposed skin frequently.
  - Clean and cover any exposed or open wounds.
- Always ensure that power is turned off before entering any flooded area and avoid touching any exposed electrical lines.
  - Only use equipment that is approved for use in water.
- Make sure your home is safe to enter after any flooding event. Floodwaters can damage the foundation and cause structural damage that makes a building unsafe to enter.
- Carefully check for snakes, venomous insects, and wild animals sheltering in your home. Notify animal control for removal of stray pets or wild animals.
- Be aware of the temperature.
  - If you are working in the cold, dress appropriately and take warming breaks. Change wet clothes frequently, especially shoes, boots, and socks.
  - If you are working in the heat, take cooling breaks and stay well hydrated.

**Tips for repairs**

- If you are hiring contractors to repair your home, seek references and make sure they have a license.
- Be wary of unlicensed or predatory contractors. Contact your insurance company or local building inspector officials if you have any questions.
- If you are doing the repairs yourself, make sure you can perform the work safely and are able to operate any necessary equipment.
- If working with ladders, secure them properly and have a spotter hold the ladder while you are working on it.
- Look for contacts of any state or federal assistance centers to get information about financial assistance that may be available to you.



## PERSONAL PROTECTIVE EQUIPMENT | At a minimum you should have and use:

**PROTECTIVE EYEWEAR**  
Safety goggles.**GLOVES**  
Rubber gloves for working in wet conditions and leather gloves for working in dry conditions.**FOOTWEAR**  
Hard-soled shoes to prevent puncture wounds. Rubber/waterproof boots for use in wet areas.**RESPIRATORS**  
N95 and elastomeric respirators are best but must be tight fitting. Surgical/cloth masks filter large particles but are not as good as an N95 or elastomeric respirator.**PROTECTIVE OUTERWEAR**  
Coveralls or fishing waders if working in deep floodwater.

## LINKS AND RESOURCES:

NIEHS Worker Training Program (WTP) National Clearinghouse for Worker Safety and Health Training:  
<https://tools.niehs.nih.gov/wetp/>NIEHS WTP Hurricanes and Floods Training Tools: <https://tools.niehs.nih.gov/wetp/index.cfm?id=2472>



## INUNDACIONES URBANAS: Peligros y consejos de prevención



Las inundaciones en áreas urbanas están ocurriendo con más frecuencia debido al número creciente de huracanes y otros eventos climatológicos extremos. Las inundaciones están relacionadas con una alta incidencia de lluvias que sobrepasan la capacidad de los sistemas urbanos para atender el exceso de agua.

Las inundaciones pueden ser extremadamente peligrosas, especialmente cuando el agua fluye rápidamente llenando calles, casas y edificios antes de que la gente pueda evacuar de forma segura. Algunas comunidades urbanas pueden sufrir inundaciones repetidas, algo que puede causar estrés a los dueños de viviendas debido a la carga financiera, el estrés emocional y las dificultades de vivir temporalmente en una casa dañada.

La limpieza y las reparaciones tras una inundación pueden exponer a las personas a una serie de peligros evitables. Esta hoja informativa ofrece algunos consejos para ayudar a los trabajadores y dueños de viviendas a protegerse durante una inundación urbana o después del suceso.



### ¿Cuáles son los peligros para la salud que debería conocer durante y después de una inundación?

#### Peligros estructurales:

- **Traumas** por causa de tropiezos y caídas, por pararse en objetos cortantes y por el uso de motosierras. Los escombros que caen de estructuras inestables, los clavos, el trabajo en escaleras o el uso inadecuado del equipo pueden **fracturar huesos y causar lesiones graves en la cabeza y laceraciones**.
- **Quemaduras y electrocución** causados por cables cargados de corriente eléctrica. Las quemaduras y el daño ocasionado por la electricidad pueden causar daño grave al tejido, incluso la muerte.



#### Exposición dañina:

- **Monóxido de carbono** en el aire cuando se usa equipo operado con combustible, (como las lavadoras eléctricas) y no hay buena ventilación. El envenenamiento por monóxido de carbono puede ocasionar problemas de salud graves o la muerte.
- **Agentes infecciosos** transmitidos en el agua anegada contaminada. Una acumulación de aguas negras contaminar el agua anegada que se acumula en estructuras debajo del suelo. Esta agua puede entrar en contacto con heridas, ocasionando infecciones en la piel, o si una persona se la traga accidentalmente, puede causarle vómitos o diarrea.
- **El moho** puede ocasionar o empeorar problemas pulmonares como el asma o la enfermedad de obstrucción pulmonar crónica. La humedad crónica, que no se resuelve, puede hacer que el moho invada paredes y muebles en los espacios inundados. Las esporas del moho se pueden esparcir en el aire y las personas las pueden respirar durante la limpieza de un lugar.
- **Las sustancias químicas tóxicas** como la gasolina, el petróleo o las toxinas industriales pueden causar irritación en la piel u otros problemas si se ingieren.

Esta hoja informativa está dirigida a trabajadores dueños de viviendas y dueños de negocios afectados por inundaciones en áreas urbanas.

### ¿Qué puede hacer para prevenir estos peligros?

#### Consejos para evitar los peligros estructurales y las exposiciones peligrosas:

- Nunca ingrese en una corriente de agua anegada.
- Nunca opere equipos operados por combustible en interiores.
- Nunca opere un generador eléctrico en interiores o cerca de ventanas o puertas abiertas.
- Evite exponerse al agua anegada.
  - Lávese la piel expuesta con frecuencia.
  - Limpie y cubra toda herida expuesta o abierta.
- Siempre asegúrese de que la corriente eléctrica esté apagada antes de ingresar en un área anegada y evite tocar los cables eléctricos expuestos.
  - Use solo equipo que está aprobado para usarse con agua.
- Después de una inundación, asegúrese de que su casa sea segura para entrar. Las aguas anegadas pueden dañar el cimiento causando daño estructural y haciendo que el edificio sea inseguro.
- Verifique que no haya culebras, insectos venenosos o animales salvajes refugiados en su casa. Notifique a la agencia de control de animales si necesita sacar a algún animal doméstico que no sea suyo o un animal salvaje.
- Esté atento a la temperatura.
  - Si hace frío, vístase adecuadamente y tome descansos para darse calor. Cámbiese la ropa mojada con frecuencia, especialmente zapatos, botas y calcetines.
  - Si hace calor, tome descansos para refrescarse y manténgase bien hidratado.



#### Consejos para las reparaciones

- Si va a contratar contratistas para que reparen su casa, busque recomendaciones y asegúrese de que tengan una licencia.
- Tenga cuidado con los contratistas que no tienen licencia o que son abusivos. Contacte a su agencia de seguros o a los inspectores de edificios de su localidad si tiene alguna duda.
- Si usted mismo va a hacer las reparaciones, asegúrese de que pueda realizar el trabajo con seguridad y de que es capaz de operar el equipo necesario.
- Si está trabajando con escaleras, asegúrelas bien y haga que una persona sostenga la escalera mientras trabaja en ella.
  - Busque contactos del estado o centros de asistencia federal para obtener información sobre cualquier asistencia financiera que le puede beneficiar.

### EQUIPO DE PROTECCIÓN PERSONAL | Como mínimo, debe tener y usar:



**PROTECCIÓN PARA LOS OJOS**  
Gafas de seguridad.



**GUANTES**  
Guantes de caucho para trabajar en condiciones húmedas y guantes de cuero (piel) para trabajar en condiciones secas.



**CALZADO**  
Zapatos con suela dura para prevenir heridas punzantes. Botas de caucho o impermeables para usar en áreas húmedas.



**RESPIRADORES**  
Los respiradores N95 y elastoméricos son los mejores, pero deben quedar bien ajustados. Las mascarillas quirúrgicas o de tela filtran las partículas grandes, pero no son tan buenas como los respiradores N95 o elastoméricos.



**VESTIMENTA EXTERIOR**  
Coveralls o botas altas (de pescar) si va a trabajar en agua anegada profunda.

#### VÍNCULOS Y RECURSOS:

**NIHS Worker Training Program (WTP) National Clearinghouse for Worker Safety and Health Training:**

<https://tools.niehs.nih.gov/wetp/>

**Herramientas de capacitación de NIHS WTP en respuestas tras el paso de un huracán o una inundación:** <https://tools.niehs.nih.gov/wetp/index.cfm?id=2472>



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