Water Environment Federation
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Mpox Information for Water Professionals

This document is an expansion and update of the original fact sheet prepared by the Waterborne Infectious Disease Outbreak Control (WIDOC) Focus Group of the Disinfection and Public Health Community (DPHC) of the Water Environment Federation (WEF), published in August 2023. Please see the list of authors and reviewers for more information.

Key Take-Home Messages

Mpox is a viral disease similar to smallpox that is spread through close contact and usually causes a fever and painful rash. Before 2022, most mpox cases were either in Africa or linked to travel to, or imported animals from, Africa. More recently, there has been a notable increase in the incidence and geographic spread of the disease due to two ongoing global outbreaks caused by different types ("clades") of monkeypox virus (MPXV).

What we know from clinical surveillance

- Since mid-2022, a clade II mpox outbreak has affected multiple countries, with more than 34,000 cases and 60 deaths reported in the U.S.
- As of early 2024, a clade I mpox outbreak is affecting several countries in Central and Eastern Africa. Travel-associated clade I cases have been reported in the U.S. and other countries outside Africa. Clade I is considered more virulent than clade II and has a higher case fatality rate.
- After an incubation period of 1 to 21 days, mpox typically presents with flu-like symptoms, swollen lymph nodes, and a characteristic rash. The rash consists of painful lesions that can spread across the body and last from 2 to 4 weeks.
- In the U.S., the risk to the general public from clade I mpox remains low, and clade II cases have remained below 10 per day since October 2023.

How wastewater surveillance plays a role

- MPXV DNA has been detected in wastewater from around the globe.
- Qualitative MPXV DNA results (e.g., presence/absence) are more commonly used than quantitative results.
- Many public health laboratories are testing wastewater for MPXV in the U.S., and data for 400 sites are being reported to the U.S. National Wastewater Surveillance System (NWSS).
- Both clade-specific (clade I vs. clade II) and non-clade-specific wastewater testing is being performed through NWSS.
- Wastewater surveillance for mpox can be helpful for, among other things:
  - Providing early detection and reassurance of absence of MPXV transmission
  - Enabling genomic characterization of circulating MPXV
  - Identifying increases, peaks, and declines in cases

What wastewater workers need to know

- Infectious MPXV has been isolated from untreated wastewater and therefore may be present in wastewater collected from a community with active mpox cases, whether the community's wastewater is being testing for MPXV or not.
- Understanding the effectiveness of disinfectant products, conducting job safety assessments, practicing good hygiene, and wearing appropriate personal protective equipment are important for protecting wastewater worker health.
- Many common disinfectants are effective against MPXV on surfaces, including those with chlorine dioxide, citric acid, ethanol, hydrogen peroxide, isopropyl alcohol, quaternary ammonia, or sodium hypochlorite as active ingredients. Products effective against MPXV are provided on EPA's "List Q". Sodium hypochlorite (0.05%) and detergents are effective against MPXV on fabrics during laundering.
- It is important to remember that because close physical contact with infected persons can spread mpox, any person—irrespective of gender or sexual orientation—can acquire and spread mpox.

Contents

Why It's a Concern

Mpox is a contagious viral disease related to smallpox that can spread through close contact, usually causing a painful rash and sometimes leading to serious complications. While mpox was historically confined to central Africa, recent years have seen a notable increase in both the incidence and geographic spread of the disease. Whereas the number of confirmed cases of human mpox was 36 cases per year on average between 1970 and 2015, all within African countries, this increased to 4,248 per year between 2015 and 2021 McQuiston et al. (2024a) and more than 20,000 around the world in 2024 (US CDC 2024d).

There are two ongoing global mpox outbreaks caused by different types ("clades") of monkeypox virus (MPXV):

- Since mid-2022, a **clade II** mpox outbreak has affected multiple countries, with more than 102,000 cases and more than 220 deaths reported across 122 countries between January 2022 and November 2024 (US CDC 2024e). This includes countries in the Americas, Europe, and the Middle East, as well as Australia, where the virus had not normally been found prior to 2022. In the U.S. as of January 2025, more than 34,000 cases and 60 deaths (US CDC 2024h) have been confirmed since the start of the outbreak in 2022. The number of U.S. cases peaked in late summer 2022 when case counts were averaging about 450 per day. Case counts have remained below 10 per day since October 2023 (US CDC 2024e). Clade II mpox—specifically clade IIb—continues to circulate at low levels.
- Since the beginning of 2024, a **clade I** outbreak has affected multiple Central and Eastern African countries[1], with more than 47,000 suspected cases (more than 13,000 confirmed) and more than 1,100 suspected deaths (60 confirmed) reported between January and November 2024 on the African continent (WHO 2024a). On August 14, 2024, the World Health Organization (WHO) declared the outbreak a Public Health Emergency of

[1] As of January 25, 2025, the African countries with confirmed clade I cases include Burundi, Cameroon, Central African Republic, Democratic Republic of the Congo, Kenya, Republic of the Congo, Rwanda, Sudan, Uganda, Zambia, and Zimbabwe.

International Concern (WHO 2024d). Starting in August 2024, travel-associated clade I cases have been reported outside Africa in Sweden, Thailand, India, Germany, the United Kingdom, the U.S., and Canada. In January 2025, a case of clade I mpox was reported in France involving an individual who had not traveled internationally but had been in contact with two people who had recently returned from Central Africa (CIDRAP 2025). As of January 2025, two clade I mpox cases have been reported in the U.S., one confirmed in California in an individual who traveled to Africa (CDPH 2024) and one confirmed in Georgia in an individual who had traveled to a country with sustained mpox transmission (US CDC 2024d). The case fatality rate for mpox cases reported in Africa in 2024 was 1.8% (as of November 2024) (Africa CDC 2024), which is at the lower end of the expected range of 1.4 to 14% for clade I (APHA 2022; Center for Outbreak Response Innovation 2024). Many of the countries reporting clade I cases in 2024 have also reported clade II cases, although clade information is not always available for all cases.

About the Virus

Monkeypox virus (MPXV) is an oval, enveloped, double-stranded DNA virus in the Orthopoxvirus genus of the Poxviridae family (Kugelman et al. 2014t; Forni et al. 2022; see **Figure 1**). MPXV is larger than many other viruses at 200 to 250 nm in length (see Figure 2), and contains a sizeable genome with approximately 197,000 base pairs (~197 kb) encoding for ~191 proteins (Karagoz et al. 2023). MPXV is closely related to variola virus, which causes smallpox, and vaccinia virus, which is used to make the smallpox vaccine (Flint et al. 2020).

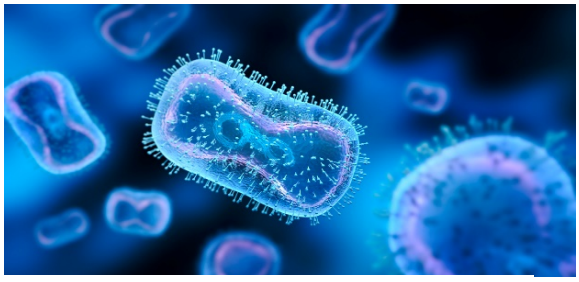


Figure 1. Medical illustration of monkeypox virus. Source: iStock Photo

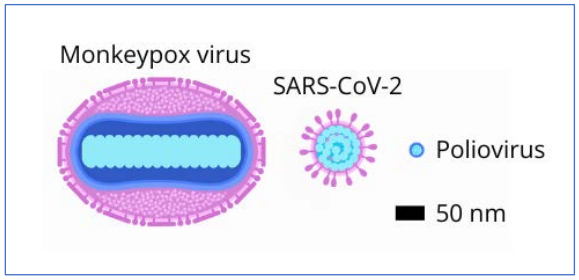


Figure 2. Relative size of monkeypox virus compared to other common viruses. Used with modifications (HIV virus removed) under Creative Commons 4.0 from https://en.wikipedia.org/wiki/Monkeypox_virus

Until 2022, mpox (the disease) was known as monkeypox, and sometimes referred to as MPX, but the WHO changed the name to mpox in November 2022 to address concerns about stigmatization (WHO 2022). The virus continues to be referred to as "monkeypox virus" or MPXV. MPXV has two distinct clades: clade I (including subclades Ia and Ib), which is the more virulent clade responsible for the outbreaks starting in 2024, and clade II (including subclades IIa and IIb), which was responsible for the outbreaks starting in 2022. Each clade has unique clinical manifestations as described below. The ongoing clade I outbreak in Central and Eastern Africa is predominantly caused by clade Ib, although clade Ia cases have also been reported (WHO 2024a).

Disease Overview

Animal hosts: Mpox is a zoonotic disease (or zoonosis), and was identified first in monkeys in 1958 (von Magnus et al. 1959) but subsequently in other animal hosts, including rodents (mice & prairie dogs) and non-human primates (Li et al. 2023). It was not identified in humans until 1970 (Breman et al. 1980) in the Democratic Republic of the Congo (known as Zaire at the time). One of the key differences between mpox and smallpox is that the latter didn't have an animal host (McQuiston et al. 2024a). The mpox outbreaks emphasize the importance of ongoing and proactive emerging, zoonotic disease surveillance and collaboration between animal and human health authorities in the One Water, One Health framework (O'Brien and Xagoraraki 2019).

Clinical features: The typical mpox clinical presentation includes flu-like symptoms (fever, muscle aches [myalgia], headache, and fatigue), swollen lymph nodes (lymphadenopathy), and a characteristic rash (Benites-Zapata et al. 2022). The flu-like symptoms usually precede the appearance of the rash during a so-called prodromal period. The rash consists of painful lesions that can spread over the entire body—including the head and neck, inside of the mouth, palms, and soles—and persist for 2 to 4 weeks, progressing through multiple stages, from macules to pustules that crust over and itch (Singh et al. 2024). In their systematic review, Benites-Zapata et al. (2022), found that about half of infected people have >100 lesions. Complications from mpox include secondary bacterial infections (such as skin infections, pneumonia, and sepsis) and ocular lesions that can lead to hospitalization and death (Forni et al. 2022; Begley et al. 2024).

During the global clade II outbreak starting in 2022, atypical clinical presentations of mpox have been observed, including the appearance of a rash without being preceded by flu-like symptoms, a rash that manifests in only one stage rather than progressing through multiple stages or is confined to a single lesion or only a few lesions on only one site of the body and doesn't necessarily appear on the palms and soles (Singh et al. 2024; US CDC 2024a). Asymptomatic cases are also possible.

Transmission: For both clade I and clade II MPXV, human-to-human transmission can be thought of as falling into three categories:

1. **Proven transmission (US CDC 2024c):**
- Direct contact with body fluids (including respiratory secretions) or lesions of a positive case
- Transplacental
- Contact with contaminated surfaces (*i.e.,* fomites) such as bedding and clothing
- Contact with infected animals and their waste

2. **Rare/infrequent but documented transmission:**
- Needle stick injury in healthcare (Caldas et al. 2022; Safir et al. 2023)

3. **Unproven and undocumented, but plausible, transmission:**
- Respiratory transmission without direct contact (i.e., airborne transmission; Beeson et al. 2023)
- Human fecal wastes, wastewaters, and biosolids
- Environmental waters

Asymptomatic transmission of MPXV has not been documented, but the related smallpox virus can be transmitted by asymptomatic cases. Because close physical contact with infected persons can spread mpox, any person - regardless of gender or sexual orientation - can acquire and spread mpox.

***Incubation period*:** The incubation period for mpox infection ranges from 1 to 21 days (WHO 2024c) although most patients develop symptoms within 7 to 14 days after exposure (Moore 2023). During the incubation period, an infected person doesn't have any symptoms.

***Diagnosis*:** Because mpox can be difficult to distinguish from other skin conditions—such as chickenpox, eczema, herpes, measles, scabies, syphilis, and others—testing is needed for a definitive diagnosis (WHO 2024c). Diagnostic testing is usually accomplished using PCR to detect viral DNA on swabs collected from lesions (Thornhill et al. 2022; US CDC 2024b). Different PCR assays are used, depending on what type of mpox is being tested for. For example, the non-variola orthopoxvirus (NVO) assay detects MPXV, but also other orthopox viruses such as cowpox virus and vaccinia virus. PCR assays for detecting and differentiating clade I and clade II are also available, as are PCR assays for some subclades, such as clade Ib that is predominating in the current outbreak in Central and Eastern Africa (Schuele et al. 2024). Sequencing, including whole-genome (Wawina-Bokalanga et al. 2024) and target enrichment next-generation (Bbosa et al. 2024) approaches, have also been used to determine the MPXV clade.

***Risk groups*:** Anyone who has close sexual or non-sexual contact with someone with mpox symptoms is at risk for being infected. Those at risk for severe or fatal mpox illness include persons who are very young, elderly, or immunocompromised (McQuiston et al. 2024). While anyone can be infected with mpox, the CDC reports that infections during the 2022 outbreak were "primarily spread by sexual contact among gay, bisexual, and other men who have sex with men" (McQuiston 2023). It is therefore important that any communications on the topic address equity and minimize stigma. As of November 2024, the risk to the U.S. from the clade I outbreak in Central and Eastern Africa is low for the general public, children, and adults, and low to moderate for men who have sex with men (MSM) and people who have sex with MSM (US CDC 2024f).

***Mortality*:** Mpox infection mortality differs by clade, with clade I having a case fatality rate (CFR) of up to 10% or higher (APHA 2022; US CDC 2024a) and clade II usually having a CFR of <1% (US CDC 2024a). During the ongoing clade I outbreak, mortality was nearly 5% for persons with suspected clade I cases of mpox in the Democratic Republic of the Congo (McQuiston et al. 2024b), although it is expected that CFR among infected persons with access to basic medical care and nutritional support would be lower (e.g., <2%; Pittman et al. 2023). During the clade IIb outbreak in the U.S., the CFR was <0.2% (McQuiston 2023).

Clinical surveillance: Mpox is a nationally notifiable disease in the U.S. as part of the National Notifiable Diseases Surveillance System (NNDSS). The NNDSS relies on voluntary reporting of cases for about 120 diseases, including cases that meet the mpox case definition. Many states encourage clinicians and laboratories to report confirmed mpox cases to their local health departments within one day of identification. CDC's National Electronic Disease Surveillance System Base System (NBS) helps health departments share

notifiable disease data, including mpox case data, with CDC, which provides weekly updates for reported mpox cases.

Presence in Wastewater

Shedding: People infected with mpox can shed MPXV via blood, feces, respiratory secretions, saliva, semen, skin, and urine (WHO 2024b)—all of which can end up in wastewater. Both infectious virus and viral DNA have been documented in human excreta and wastewater:

- Infectious MPXV has been isolated from anogenital swabs, nasopharyngeal swabs, saliva, semen, swabs of skin lesions, and urine of *symptomatic* cases (Lapa et al. 2022; Hernaez et al. 2023; Noe et al. 2023; Piralla et al. 2024) and rectal swabs of *asymptomatic* mpox cases (De Baetselier et al. 2022), suggesting that it could be expected in human feces even in the absence of known cases. Infectious MPXV has been isolated from wastewater (Ampuero et al. 2023).
- MPXV DNA has been detected in anogenital swabs, blood, feces, nasopharyngeal swabs, respiratory droplets, saliva, semen, skin swabs, throat swabs, and urine of symptomatic cases (Adler and Taggart 2022; Antinori et al. 2022; Peiro-Mestres et al. 2022; Hernaez et al. 2023; Noe et al. 2023). MPXV DNA has also been isolated from air samples from medical consultation rooms with symptomatic cases (Hernaez et al. 2023) and from the air and surfaces inside isolation rooms with symptomatic cases (Gould et al. 2022; Marimuthu et al. 2023). MPXV DNA has also been detected in wastewater (Bowes et al. 2023; Sherchan et al. 2023; Mejia et al. 2024).

Shedding can occur for a few weeks or longer. In their study of 353 patients, Piralla et al. (2024) found that infectious MPXV could be detected in anogenital and urethral swabs from infected cases for up to 21 days after symptom onset and for up to 28 days in skin swabs. In the same study, Piralla et al. (2024) found that the median shedding duration of MPXV DNA from skin was 16 days, although some patients demonstrated persistent skin shedding for more than 21 days.

In addition to being shed by infected humans, infected animals can also shed MPXV (WHO 2024b). For example, infectious MPXV has been recovered from fecal, nasal, ocular, and oral swabs from prairie dogs infected in a laboratory setting (Hutson et al. 2009). However, it is unlikely that animal shedding would contribute to the wastewater MPXV signal in the U.S.

Detection: Molecular (i.e., culture-independent) methods are commonly used to detect MPXV DNA in wastewater. These include digital PCR (Brighton et al. 2024; Foulkes et al. 2024), droplet digital PCR (Wolfe et al. 2023; Boehm et al. 2024; Miyani et al. 2024), and quantitative PCR (Sherchan et al. 2023; Bagutti et al. 2024; Calabria de Araujo et al. 2024; Julian et al. 2024; Mejia et al. 2024). The detection of MPXV DNA with PCR-based methods does not necessarily mean that infectious virus is present, although infectious MPXV has been isolated from wastewater (Ampuero et al. 2023).

In addition to quantification, sequencing of PCR products from wastewater has also been performed to confirm the clade composition (Bowes et al. 2023; Mejia et al. 2024).

Persistence in the environment and untreated wastewater: Both infectious MPXV and MPXV DNA are thought to persist for days on environmental surfaces. For example, viable MPXV was isolated from swabs taken of home objects (including bedding, towels, and furniture) three days after a travel-related case had left the home (Atkinson et al. 2022). Similarly, MPXV was successfully cultured from swabs of home objects collected 15 days after an infected person left the home for the hospital, with porous (bedding, clothing) surfaces more likely to contain viable virus than non-porous (metal, plastic) surfaces (Morgan et al. 2022). Researchers for these studies also recovered MPXV DNA from the environmental surfaces during the same time frames.

Infectious MPXV was also shown to be stable in wastewater after being added as a spike (at an initial concentration of 10^5 plaque forming units/mL), with a half-life of 5.7 days (95% confidence interval: 4.6 to 8.1 days) (Yinda et al. 2023). It is not known whether MPXV shed by individuals (non-spiked scenarios) would remain similarly viable in wastewater. To our knowledge, no studies on the persistence of MPXV DNA in wastewater have been completed.

Fate in wastewater treatment processes: Most of the research on the fate of viruses in wastewater treatment has focused on non-enveloped enteric viruses[2] (Katayama et al. 2008; Kitajima et al. 2014; Schmitz et al. 2016). However, enveloped viruses, such as MPXV (and influenza, RSV, and SARS-CoV-2), are thought to be more susceptible to inactivation than their non-enveloped counterparts—although DNA viruses (like MPXV) are generally more stable than their RNA counterparts (Tiwari et al. 2023; WHO 2024b). To our knowledge, no studies have considered the impact of wastewater processes on the viability of MPXV. However, it is reasonable to assume that chlorination would be effective against MPXV based on the study by Pitol et al. (2024a) that demonstrated that both 0.05% and 0.5% solutions of sodium hypochlorite reduced MPXV to non-detectable levels on both porous and non-porous surfaces. Additional research is needed to more fully understand the fate of MPXV, especially infectious virus, in wastewater treatment processes. However, current wastewater and drinking water treatment and monitoring practices are expected to be sufficient to protect public and environmental health.

Suitability for Wastewater Surveillance

Multiple studies have demonstrated the detection of MPXV DNA in wastewater around the world, including in Asia (Wong et al. 2023; Xu et al. 2024), Europe (de Jonge et al. 2022; Wurtzer et al. 2022; Bartackova et al. 2023; Giron-Guzman et al. 2023), North America (Bowes et al. 2023; Sherchan et al. 2023; Mejia et al. 2024), and South America (Ampuero et al. 2023; Calabria de Araujo et al. 2024). For MPXV, qualitative results (e.g., presence/absence) are more commonly reported than quantitative results, therefore correlations between clinical data and wastewater data are less common for mpox than for COVID-19, influenza, and RSV. Quantitative MPXV wastewater data are unlikely to be useful in areas with low mpox prevalence (WHO 2024b), as has been the case in the U.S. since 2022. Detection of MPXV

[2] Enteric viruses are defined by their habitat, namely, the gastrointestinal tract of mammals. They include viruses in the *Enterovirus* genus (such as coxsackieviruses, echoviruses, enteroviruses, polioviruses, and rhinoviruses), but also adenoviruses, astroviruses, noroviruses, rotaviruses, and others.

DNA in wastewater has been shown to provide an early warning of cases (Islam et al. 2024), highlight undiagnosed community transmission (Giron-Guzman et al. 2023), and complement traditional public health surveillance approaches (Foulkes et al. 2024). Further, Adams et al. (2024) concluded, based on an analysis of U.S. National Wastewater Surveillance System (NWSS) mpox data between August 2022 and May 2023, that the absence of detectable levels of MPXV DNA in a community's wastewater "can provide reassurance that large numbers of cases are not present".

The WHO (WHO 2024b) recommends the use of mpox wastewater and environmental surveillance for:

- Providing early detection, as well as reassurance of absence, of MPXV transmission
- Enabling genomic characterization of the circulating MPXV
- Identifying increases, peaks, and declines in cases
- Identifying hot spots
- Informing public health decisions, such as messaging, expanded testing, vaccines and other health system resources
- Contributing to the evaluation of the effectiveness of case-based surveillance and other interventions

Due to its public health significance and amenability to wastewater-based detection, the NWSS target panel was expanded to include MPXV testing in October 2022. Currently, the NWSS mpox data webpage features a map of site-level detections during the previous four weeks that users can filter by the type of mpox testing being conducted (clade I, clade II, or non-clade-specific, such as with the NVO assay). Detections are defined as falling into one of four categories: **persistent detection** (MPXV was detected in more than 80% of samples in the past 4 weeks AND the most recent detection was within the past 2 weeks), **detection** (MPXV was detected in 1% to 80% of samples in the past 4 weeks AND the most recent detection was within the past 2 weeks), **no recent detection** (MPXV was not detected in any samples in the past 2 weeks), or **no recent data** (fewer than 3 samples were submitted in the past 4 weeks). At the end of 2024, MPXV wastewater testing data were available for 233 sites using non-clade specific testing and 159 sites with clade II-specific testing. Only 2 sites—both using clade II-specific testing—showed a detection during the 4-week time period at the end of 2024, while the remainder of sites showed "no recent detection".

Another dataset for mpox in wastewater is available from WastewaterSCAN (2024). Between June 2022 and November 2024, WastewaterSCAN detected clade II mpox in 1,065 out of >56,000 samples, across 192 water resource recovery facilities (WRRFs), with most (>80%) detections occurring in 2022—consistent with the pattern of the clade II outbreak in the U.S. (A. Bidwell, personal communication, December 12, 2024).

An increase in MPXV clade I-specific wastewater testing is expected in 2025 in response to the ongoing global mpox outbreak. When MPXV clade I DNA is detected in wastewater, the CDC will work with jurisdictions to consider wastewater data together with other surveillance data to inform potential public health response actions, such as increasing clinical testing or enhancing outreach and education to healthcare providers and the public. It should be noted that although MPXV clade I (but not clade II) is considered a Federal Select Agent, the U.S. Department of Agriculture (USDA) has clarified that the detection of MPXV clade I DNA in wastewater is not considered an identification of a select

agent and, therefore, any wastewater samples in which mpox clade I nucleic acid is detected are not subject to the select agent and toxin regulations.

Utilities should coordinate with their public health partners to learn whether mpox is included in wastewater testing within their community and, if so, whether clade-specific testing is planned or underway or if/when it might be added. Utilities are encouraged to provide samples for mpox testing if they feel comfortable doing so, especially now that the USDA has confirmed that any MPXV clade I DNA detections are exempt from select agent and toxin regulation requirements.

Preventing Infection When Working with Wastewater

Routes of exposure: While uncertainties remain about the persistence of unspiked, infectious MPXV in wastewater, it is reasonable to assume that infectious MPXV may be present in any untreated wastewater in which MPXV DNA is detected. Exposure to MPXV in wastewater can happen through inhaling aerosols during collection and treatment or splashing of wastewater onto ocular or oral mucous membranes (WEF 2020). Contact with viruses on contaminated surfaces (fomites) followed by touching the face, especially the eyes and nose, is also a potential exposure route. It is important to keep in mind that most surfaces near wastewater collection and treatment equipment are likely to be contaminated with wastewater, and the presence of abrasions, open wounds, and punctures may increase the risk of transmission of any pathogen.

Wastewater workers may be at risk of exposure to MPXV through contact with household or workplace items that have been contaminated by bodily fluids, skin, or lesions of confirmed or suspected mpox cases. They may also be exposed through direct or close respiratory contact with infected individuals. It is important to note that individuals infected with mpox can begin shedding the virus before symptoms appear or even without showing any symptoms, making it difficult to identify contagious people. As highlighted earlier, mpox can be acquired and transmitted by anyone, regardless of gender or sexual orientation.

Infection prevention measures: The worker safety recommendations of the WEF Blue-Ribbon Panel (WEF 2020) remain relevant for wastewater workers for MPXV and other infectious agents in wastewater. These recommendations are consistent with the CDC's guidance for reducing health risks to workers handling human waste or sewage (US CDC 2023). Understanding appropriate disinfectant products, conducting job safety assessments, practicing good hygiene, and using personal protective equipment all play a role in preventing mpox—and other pathogen—infection from wastewater. In addition, vaccination may also be appropriate for some groups.

Disinfectant products

- Like other large, enveloped viruses, MPXV is expected to have less intrinsic resistance to inactivation by chemical and physical modes of disinfection compared to non-enveloped viruses. The U.S. Environmental Protection Agency (EPA) has designated MPXV as a Tier 1, easy-to-disinfect virus, and numerous disinfectants on EPA's "List Q" are effective against Tier 1 viruses (US EPA 2023). The products on this list contain chlorine dioxide, citric acid, ethanol, hydrogen peroxide, isopropyl alcohol, quaternary

ammonia, sodium hypochlorite and other common disinfectants as active ingredients.

- Pitol et al. (2024a) demonstrated that both 0.05% and 0.5% solutions of sodium hypochlorite reduced MPXV to non-detectable levels on both porous and non-porous surfaces. This is in the range of CDC's recommendation for disinfection of surfaces (1:50 dilution of 5.25% sodium hypochlorite [0.1%], or about 75 mL [1/3 cup] of household bleach in a total of 1 gallon of water) with a contact time of 1 minute.

Job safety assessments (JSAs)

- JSAs should follow the protocols outlined in WEF (2020). Please email nwbe@wef.org for JSA templates if needed.
- To inform their JSAs, utilities should coordinate with local public health agencies and healthcare institutions to understand the risk of MPXV in their wastewater. Specifically, utilities overseeing collection systems should consider contacting hospitals and clinics who may treat positive mpox cases to determine whether patient wastewater is being treated as Category A waste (similar to Ebola).

Hygiene

- After handling wastewater or touching surfaces potentially contaminated with wastewater, hands should be washed with soap and water or cleaned with an alcohol-based hand sanitizer (ABHS), although soap and water should be used if hands are visibly soiled. It is worth noting that, as explained in Weber et al. (2023), "[w]earing gloves is not a substitute for hand hygiene".
- While working with wastewater and near surfaces potentially contaminated with wastewater, avoid touching the face, mouth, eyes, nose, or open sores or cuts, and do not smoke or chew tobacco or gum. In addition, sores and cuts should be covered with water-resistant band aids.
- Household or workplace items that come into contact with confirmed or suspected mpox case bodily fluids, skin, or lesions should be laundered with bleach and/or detergent. Pitol et al. (2024b) found that sodium hypochlorite (0.05% solution), liquid sanitizer, and 2 powdered laundry detergents dissolved in room temperature water completely inactivated MPXV (> 3 $\log_{10}$ reduction) on both cotton and polyester fabrics. In the same study, water at 70°C alone (without bleach, sanitizer or detergent), was shown to completely inactivate MPXV, as well[3]. Laundering of soiled coveralls at utilities may require additional considerations in compliance with ASTM or industry standards if coveralls are flame, thermal and/or arc resistant.

[3] This is consistent with the US CDC (2024g) recommendation to launder smallpox-contaminated laundry items at no less than 71°C (160°F) with detergents and bleach to achieve inactivation of any infective viruses present. However, most household water heaters are set well below this target at between 50°C to 55°C (120°F to 130°F) to prevent scalding. If washing machines do not have a heating element, water heaters would have to be adjusted to achieve higher temperatures. Because the higher temperature of 71°C (160°F) is not necessarily practical or recommended in home systems, use of bleach with detergent in the laundering cycle is strongly recommended in situations where mpox is a concern.

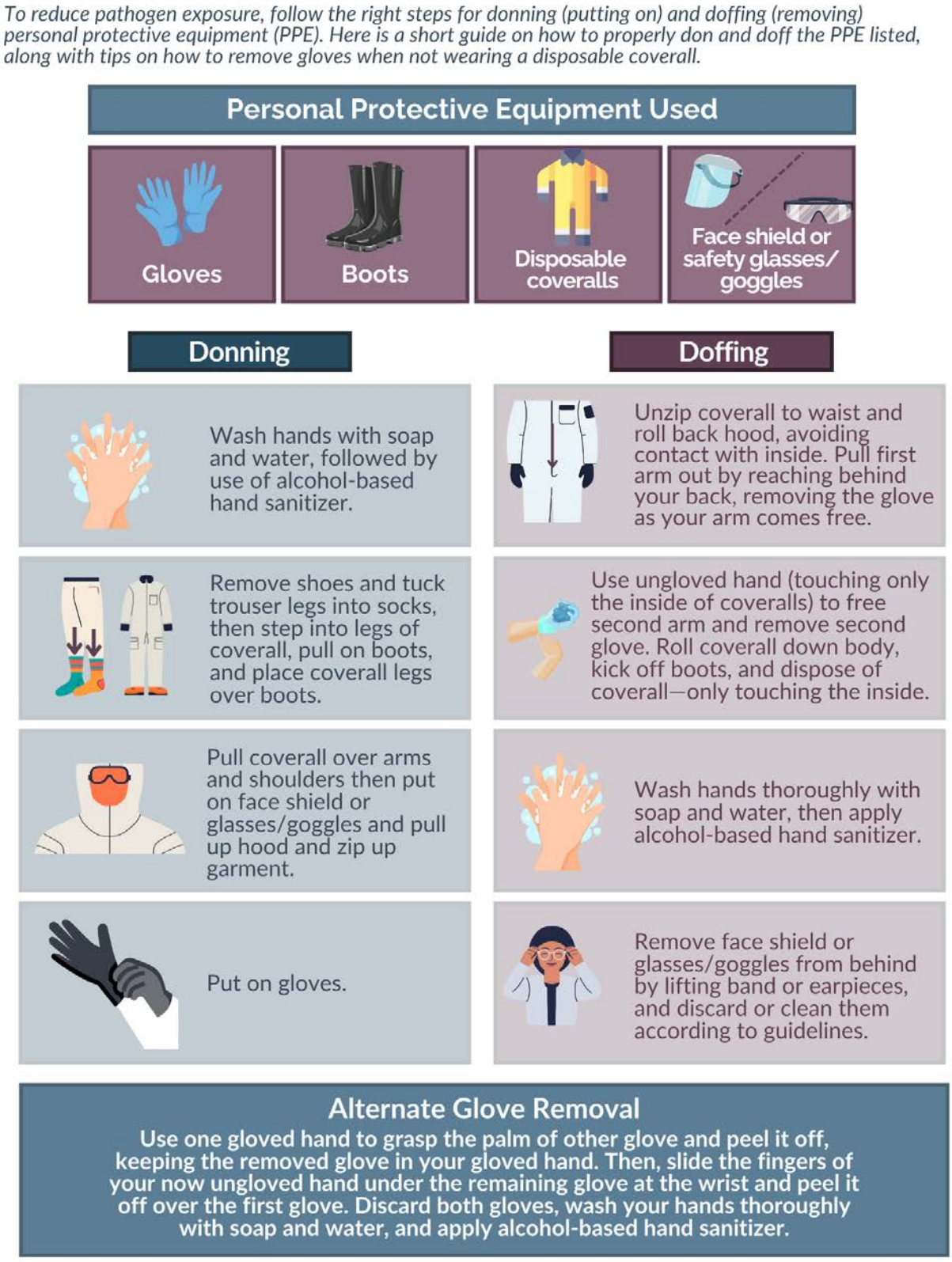
Personal protective equipment (PPE)

- PPE should be selected to prevent contact with wastewater, either directly (through splashes, contact transfer, or whole-body contact) or indirectly (through touching contaminated surfaces).
- Appropriate PPE may include gloves, boots, coveralls (such as Tyvek suits), face shields, and safety glasses/goggles (LeChevallier et al. 2020).
- Care should also be taken to prevent cuts or punctures when handling wastewater through the use of durable gloves. Gloves should be changed when torn or heavily contaminated.
- Proper procedures for donning (putting on) and doffing (removing) PPE to minimize pathogen exposure should be followed. **Figure 3** provides an example of donning and doffing gloves, boots, disposable coveralls, and a face shield or safety glasses/goggles, including steps on how to remove gloves when not wearing a disposable coverall.
- Reusable PPE, such as boots, face shields and goggles, should be cleaned after each use. Visibly soiled PPE can be cleaned with soap and water, followed by a dilute bleach solution (1 part 5.25% sodium hypochlorite with 49 parts water) or a disinfectant on EPA's "List Q". For PPE that is not visibly soiled, or not amenable to washing with soap and water, a disinfectant on EPA's "List Q" can be used. In addition, PPE should also be inspected before each use.

Vaccination

- Two vaccines—ACAM2000 and JYNNEOS—are approved by the U.S. Food and Drug Administration for prevention of mpox, although only JYNNEOS has been used during the clade II outbreak. JYNNEOS requires 2 doses given 4 weeks apart and confers maximum protection 2 weeks after the second dose. Unpublished data from a CDC study in the Democratic Republic of the Congo suggests that immunity does not wane for at least 5 years.
- CDC's Advisory Committee on Immunization Practices (ACIP) (Rao et al. 2022) has identified several groups at high risk of exposure to mpox. These include research laboratory personnel working with orthopoxviruses, clinical laboratory personnel performing diagnostic tests for orthopoxviruses, and health care workers in orthopoxvirus response teams designated by appropriate authorities. The risk of exposure for wastewater workers is considered low (unless otherwise determined by a JSA), reducing the need for industry-wide ACAM2000 or JYNNEOS vaccination campaigns.
- Individuals who have had known or suspected exposure to someone with mpox—such as having had a sex partner diagnosed with mpox in the past 2 weeks—should consider receiving the vaccine. It is recommended to consult with a healthcare provider to determine if vaccination is necessary. Vaccines may be available through healthcare providers, local pharmacies, or local health departments.

Figure 3. Donning and doffing personal protective equipment for reducing pathogen exposure



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