DISEASE RESPONSE STRATEGY
JAPANESE ENCEPHALITIS

FAD PReP
Foreign Animal Disease Preparedness & Response Plan

United States Department of Agriculture

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The Foreign Animal Disease Preparedness and Response Plan (FAD PReP) *Disease Response Strategy: Japanese Encephalitis (2013)* provides strategic guidance for responding to an animal health emergency caused by Japanese encephalitis (JE) in the United States.

This *JE Disease Response Strategy* was last updated in **August 2013**. Please send questions or comments to

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INTRODUCTION

Japanese encephalitis (JE) is an arthropod-borne viral disease of swine, equids, and humans. The Japanese encephalitis virus (JEV) is a *Flavivirus* and a member of a serological group that includes West Nile virus (WNV) and nine others that together affect every continent except Antarctica. This zoonotic disease is known to cause 30,000–50,000 cases of human encephalitis each year. JE also causes significant reproductive losses in swine and encephalitis in horses.[1]

JE is a World Organization for Animal Health (OIE) notifiable disease due to its ability to spread rapidly and cause severe illness. Additionally, JE is a significant public health risk, causing 10,000–15,000 deaths annually. This response strategy was drafted in recognition of its importance to both animal and human health. It is intended to provide animal health emergency responders with the information necessary to respond to JE, should it enter the United States. This disease strategy covers the pertinent etiology and ecology of JE as well as control and eradication strategies. Further information and in-depth reviews of JE can be found in the references and resources section at the end of this document.

Other documents provide further detail on incident coordination and general foreign animal disease (FAD) response. The *Animal and Plant Health Inspection Service (APHIS) Foreign Animal Disease Framework: Roles and Coordination* (Foreign Animal Disease Preparedness and Response Plan [FAD PReP] Manual 1-0) provides an introduction to APHIS FAD preparedness and response, an overview of the roles and responsibilities of different government agencies involved in an FAD response effort, as well as information on funding, incident management, and communications. Additionally, an overview of FAD response strategies is available in the *APHIS Foreign Animal Disease Framework: Response Strategies* (FAD PReP Manual 2-0). These documents and other resources are available here: http://www.aphis.usda.gov/animal_health/emergency_management. They are also available on the APHIS Intranet for APHIS employees: http://inside.aphis.usda.gov/vs/em/fadprep.shtml.

NATURE OF THE DISEASE

JEV is a vector-borne, positive-strand, RNA virus that belongs to the *Flaviviridae* family, genus *Flavivirus*. There is only one known serotype of JEV, but four

[1] Mackenzie JS, Gubler DJ, Petersen LR. 2004. "Emerging flaviviruses: the spread and resurgence of Japanese encephalitis, West Nile, and dengue viruses." *Nature Medicine Supplement*. 10(12): S98–S109.

genotypes have been identified through sequencing of the viral pre-membrane region. Many different species are susceptible to natural JEV infection: swine, equids (primarily horses), birds (90 wild and domestic species), cattle, sheep, goats, dogs, cats, wild mammals, reptiles, amphibians, and humans. All animals except swine and birds are considered dead-end hosts; in other words, animals experience subclinical infections with viremia levels too low to contribute to transmission.[2]

JEV is found throughout eastern, southeastern, and south Asian countries as well as parts of the Western Pacific. Its reach extends to the Indian subcontinent, as far west as Pakistan and as far south as northern Australia. JEV has never been found in the United States.

Transmission and Reservoirs[3,4]

JEV is transmitted to mammal hosts through the bite of a mosquito, typically of the *Culex* species. In Asia, the primary species responsible for transmission is *Culex tritaeniorhynchus.* Other important species involved in transmission include *Cx. gelidus, Cx. fuscocephala,* and *Cx. annulirostris*. In the United States, *Cx. tarsalis* and *Cx. pipiens* are the primary vectors for transmission of flaviviruses.

The virus is maintained by continually cycling between the mosquito vector and swine or ardeid wading birds (such as herons and egrets), both JEV reservoirs. While wading birds have been implicated in multiple studies, many species of birds are competent reservoir hosts where viral amplification and transmission to arthropod vectors frequently occurs. Anseriformes (waterfowl) have been broadly identified as an efficient reservoir of JEV. Swine and birds serve as amplifying and maintenance hosts due to their high and prolonged viremia. Infection with JEV results in subclinical infections in these animals. The mechanism of maintenance through the winter in temperate regions is suspected to be due to infected hibernating mosquitoes or transovarial passage, though these hypotheses require more evidence to be certain.[5]

Horses and humans do not play an important role in the natural spread of JEV and are regarded as aberrant hosts. There has been no evidence that contact—such as two horses sharing a feed bucket—will result in JEV transmission. While horses

[2] Van de Hurk AF, Ritchie SA, Mackenzie JS. 2009. "Ecology and geographical expansion of Japanese encephalitis virus." *Annual Review of Entomology.* 54: 17–35.

[3] USDA APHIS Centers for Epidemiology and Animal Health (CEAH) National Surveillance Unit (NSU). 2011. *Draft Case Definitions for Japanese Encephalitis.*

[4] Fischer M, Lindsey N, Staples E, Hills S. 2010. "Recommendations of the Advisory Committee on Immunization Practices: Japanese Encephalitis Vaccines." *Morbidity and Mortality Weekly Report.* 59:1–27.

[5] United States Animal Health Association. 2008. *Foreign Animal Diseases*. 7th Ed.

may have sufficient viremia to infect mosquito vectors, evidence does not suggest that they have any epidemiological role in transmission.[6]

Humans primarily become infected through the bite of a mosquito; other routes such as inhalation of aerosols or direct contact with contaminated mucus membranes or infective fluids in the laboratory or field setting while collecting tissues samples, are also possible but significantly less likely.

Incubation Period

The incubation period for JE in horses is between 8–10 days. For experimentally infected swine, signs of infection, fever, and viremia were observed 24 hours post inoculation with other clinical manifestations apparent within 3 days post inoculation. For the purpose of the OIE, the incubation period for JE is 21 days.[7]

Clinical Signs[8,9]

Horses: Infection is most often inapparent with clinical cases occurring infrequently and varying in severity. Subclinical cases are the most common. The OIE *Technical Disease Card* for JE describes three syndromic manifestations: transitory, lethargic, and hyperexcitable. Horses affected by the transitory type may experience fever, anorexia, lethargy, and congested or jaundiced mucosal membranes; most recover in 2–3 days. Those affected by the lethargic type syndrome may display neurologic signs (in addition to signs attributed to the transitory type) such as difficulty swallowing, lack of coordination (ataxia), and impaired vision. The most severe form, the hyperexcitable type, is characterized by high fever, profuse sweating, and neurological signs such as aimless wandering, aggressive or wild behavior, blindness, and muscle tremors. The hyperexcitable type may result in collapse, coma, and death. Should the horse recover, neurological problems may persist.

Swine: Reproductive disease is characteristic among swine. Stillborn or mummified fetuses delivered at full term are most common. Abortions and piglets born with muscle tremors/convulsions followed by piglet death are also consequences of JE. Swine that are not pregnant do not typically show signs of infection or experience only mild transient fever. Encephalitis is occasionally observed in swine under 6 months of age. Other rare signs of JE include infertility in boars that may be permanent depending on the severity of the illness.

[6] Fernández PJ, White WR. 2010. "Japanese Encephalitis" in *Atlas of Transboundary Animal Diseases*. World Organization for Animal Health (OIE).

[7] OIE. Article 8.7.1, *Terrestrial Animal Health Code*. 2012. www.oie.int.

[8] Center for Food Security and Public Health, Iowa State University. 2007. *Technical Fact Sheet: Japanese Encephalitis*. www.cfsph.iastate.edu

[9] OIE. 2009. "Japanese Encephalitis." *Technical Disease Card*. www.oie.int.

Humans: Clinical signs in humans vary by which area of the nervous system is affected. Disease pathology begins with febrile illness and may progress into severe neurological signs such as flaccid paralysis and Parkinsonian syndrome. Fatal cases usually occur when the patient slips into a coma.

Morbidity and Mortality

Among swine, reproductive losses can reach 50–70 percent; mortality in non-immune infected piglets may reach nearly 100 percent. Mortality rates are close to zero for adult swine.[10]

In horses, morbidity rates have been reported from less than 1 percent to just over 1 percent; case fatality rates are typically 5 percent to 15 percent.[11]

It is estimated that annually there are almost 68,000 cases of JE among humans occurring in 24 endemic countries. Less than 1 percent of all infections with JEV result in JE. Case fatality rates typically range from 20 to 30 percent, with children and the elderly most likely to succumb to a fatal infection.[12]

Differential Diagnosis

When considering a potential diagnosis of JE in the United States the following diseases should also be included in the differential diagnosis:[13]

Horses

- African horse sickness,
- babesiosis (equine piroplasmosis),
- bacterial or toxic encephalopathies,
- Borna disease,
- botulism,
- cerebral nematodiasis or protozoodiasis,
- eastern equine encephalitis,
- equine herpesvirus myeloencephalopathy,

[10] Fernández PJ, White WR. 2010. "Japanese Encephalitis" in *Atlas of Transboundary Animal Diseases.* OIE.

[11] Fernández PJ, White WR. 2010. "Japanese Encephalitis" in *Atlas of Transboundary Animal Diseases.* OIE.

[12] Campbell GL, et al. 2011. "Estimated global incidence of Japanese encephalitis: a systematic review." *Bulletin of the World Health Organization*. 89:766–774. http://www.who.int/bulletin/volumes/89/10/10-085233/en/index.html.

[13] OIE. 2009. "Japanese Encephalitis." *Technical Disease Card.* www.oie.int.

- equine infectious anemia,
- equine protozoal myeloencephalitis,
- hepatic encephalopathy,
- leucoencephalomalacia (*Fursarium moniforme*),
- other viral encephalitides, including but not limited to
  - eastern equine encephalitis
  - Murray valley encephalitis
  - western equine encephalitis
  - Venezuelan equine encephalitis
  - West Nile encephalitis.
- rabies,
- tetanus, or
- viral equine rhinopneumonitis.

Swine

- blue-eye disease (porcine rubulavirus),
- brucellosis,
- classical swine fever,
- coronavirus,
- encephalomyocarditis virus,
- hemagglutinating encephalomyelitis,
- Menangle virus,
- other causative agent of SMEDI (stillbirth, mummification, embryonic death, and infertility),
- porcine parvovirus,
- porcine reproductive and respiratory syndrome,
- pseudorabies,

- Teschen/Talfan,
- water deprivation/excess salt, or
- viral/fever induced abortion.

Laboratory Diagnosis[14]

Laboratory diagnostic testing for JEV will be performed at the National Veterinary Services Laboratories in Ames, Iowa or at the Foreign Animal Disease Diagnostic Laboratory in Plum Island, New York. A diagnosis of JE is confirmed by virus isolation from cerebrospinal fluid (CSF) and/or central nervous system tissue of affected animals. Serology may also aid in identification; available tests include hemagglutination inhibition (HI), enzyme-linked immunosorbant assay (ELISA), complement fixation (CF), and virus neutralization (VN). Serological testing should be a means to rule-in JEV, as these tests have cross-reactivity with other flaviviruses. Confirmation should be completed by other means; reverse transcriptase polymerase chain reaction (RT-PCR), immunofluorescence, and virus isolation are appropriate.

The sample of choice is fresh brain tissue; other suitable samples for testing include whole blood, CSF, and spinal cord. Collected samples should be refrigerated and shipped on wet ice (for testing within 48 hours). Tissues can be frozen and shipped on dry ice if testing will not occur within 48 hours after collection.

Manipulations of this virus, including confirmation of disease from any diagnostic specimens, require Biosafety Level (BSL)-3 practices, containment equipment, and facilities. Any work in live animals would similarly require BSL-3 Ag practices.

Vaccination and Treatment

Modified live and inactivated vaccines are available for swine and humans; inactivated vaccines are available for horses. The vaccines available for horses and swine are protective against all genotypes of JEV. Vaccination of swine, the amplifying hosts, benefits horses and humans by decreasing the viral titers of swine, thereby reducing the transmission of JE. Vaccination of horses prevents clinical disease and possible sequelae. There is not currently a United States Department of Agriculture (USDA) licensed vaccine in the United States.[15]

The inactivated vaccines are produced in mouse brain, primary hamster kidney (PHK) cells, or Vero cells. Manufactured and used in China, Korea, and Japan,

[14] USDA APHIS CEAH NSU 2011. *Draft Case Definitions for Japanese Encephalitis.*

[15] USDA APHIS Center for Veterinary Biologics. 2013. Veterinary Biological Products: Licensees and Permittees. http://www.aphis.usda.gov/animal_health/vet_biologics/publications/CurrentProdCodeBook.pdf

these vaccines require multiple doses and produce a poor protective response; still, they have achieved their purpose by reducing the incidence of human JE cases considerably. The modified live vaccine (SA14-14-2) has been attenuated via a series of passages through PHK cells followed by ultraviolet irradiation, purification, and further passage in hamsters and suckling mice.[16]

Horses are typically vaccinated with a formalin-inactivated vaccine derived from mouse brain or cell cultures. In Japan, swine receive both inactivated and modified live vaccines derived from cell cultures.[17]

IXIARO® (Novartis Vaccines), an inactivated vaccine derived from Vero cells, is available for humans in the United States. Approved for individuals 17 and older, IXIARO® is a 2-dose series; doses are administered 28 days apart with the last dose being given 1 week prior to travel.[18]

Treatment in humans with JE is supportive; rest, fluids, and pain relievers/medications to reduce fever may be effective at treating symptoms.[19] Survivors of natural infection, both animal and human, acquire long-lasting immunity.

Persistence of JEV

JEV may be inactivated by changes in temperature, pH, exposure to various chemicals and disinfectants as well as environmental impacts. Table 1 presents a more thorough picture of the persistence of JEV.

Table 1. Resistance to Physical and Chemical Action of Japanese Encephalitis Virus.

Action	Resistance
Temperature	Destroyed by heating for 30 minutes above 56 °C (132.8 °F); thermal inactivation point is 40 °C (104 °F).
pH	Inactivated in acid environment of pH 1–3 (stable in alkaline environment of pH 7–9).
Chemicals/disinfectants	Inactivated by organic and lipid solvents, common detergents, iodine, phenol iodophors, 70% ethanol, 2% glutaraldehyde, 3–8% formaldehyde, 1% sodium hypochlorite.
Environment	Virus very labile and does not survive well in environment; sensitive to ultraviolet light and gamma irradiation.

Source: OIE. Technical Disease Card, Japanese encephalitis. 2009.

[16] Beasley DWC, Lewthwaite P, Solomon T. 2008. "Current use and development of vaccines for Japanese encephalitis." *Expert Opin. Biol. Ther.* 8(1): 95 – 106.

[17] OIE. 2010. Chapter 2.7.1. *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals (2012).* www.oie.int.

[18] Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Disease, Division of Vector-Borne Diseases. 2012. "Japanese Encephalitis: Vaccine." www.cdc.gov.

[19] Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Disease, Division of Vector-Borne Diseases. 2012. "Japanese Encephalitis: Symptoms and Treatment." www.cdc.gov.

Criteria for Proof of Freedom

The OIE does not provide criteria for proof of freedom. Surveillance of susceptible animals, reservoir hosts, and mosquito vectors will be required to demonstrate proof of disease freedom.

JE RESPONSE: CONTROL AND ERADICATION

The APHIS goals of an FAD response are to (1) detect, control, and contain the disease in animals as quickly as possible; (2) eradicate the disease using strategies that seek to stabilize animal agriculture, the food supply, the economy, and to protect public health and the environment; and (3) provide science- and risk-based approaches and systems to facilitate continuity of business for non-infected animals and non-contaminated animal products.

Achieving these three goals will allow individual livestock facilities, states, Tribes, regions, and industries to resume normal production as quickly as possible. They will also allow the United States to regain JE-free status without the response effort causing more disruption and damage than the outbreak itself.

There is a large number and wide range of potential hosts and mosquito vectors present in the United States that may make the eradication of JE difficult. Should it become apparent that elimination of JE is not achievable, response efforts will focus on control of JE in domestic animal populations as needed to protect public health and to support the swine and equine industries.

Case Definitions

The following case definitions are APHIS CEAH NSU draft definitions from May 2013, and are currently under review.

Suspect case: Meets conditions either (1) OR (2):

1. Clinical signs consistent with JE in a horse or pig with:
    - A history of residence in a known or potentially endemic region; OR
    - An epidemiological link to a possible JEV exposure.
2. Clustering of equine neurologic disease occurring during the mosquito/culex season among horses vaccinated against other causes of encephalitis, e.g. rabies, West Nile virus, or eastern equine encephalitis/western equine encephalitis.

Presumptive positive case: A suspect case that is positive on at least one JEV serologic test.

Confirmed positive case: An animal from which JEV has been isolated and identified in a USDA laboratory or other laboratory designated by the Secretary of Agriculture.

REPORTING

In the United States, JE is an FAD and an OIE-notifiable disease. Suspect cases should be reported to a State Animal Health Official or Area Veterinarian-in-Charge. For more information on conducting FAD investigations please refer to Veterinary Services (VS) Guidance Document 12001.1 (which has replaced VS Memorandum 580.4) and the *FAD Investigation Manual* (FAD PReP Manual 4-0). Both are available on the APHIS Intranet for APHIS employees (http://inside.aphis.usda.gov/vs/em/fadprep.shtml).

Control and Eradication Strategies

For JEV, there are different control and eradication strategies depending on the species infected. These control and eradication strategies are based on four common epidemiological principles:

1. Prevent contact between JEV and susceptible animals.
2. Stop the production of JEV by infected or exposed animals.
3. Stop the transmission of JEV by vectors.
4. Increase the disease resistance of susceptible animals to JEV.

CONTROL AND ERADICATION IN SWINE

Swine are amplifying hosts of JEV, posing a risk to both humans and horses. To control and eradicate JEV in swine, Infected Premises (IP) should be rapidly quarantined and appropriate quarantine and movement controls implemented in the Control Area (CA) (see Quarantine and Movement Control). Domestic swine on IP may be stamped-out, as discussed in the box below. If there is any evidence that stamping-out may not be useful in controlling the outbreak, emergency vaccination of swine may be considered to stop the spread of JEV in the United States. However, there is not currently a JEV vaccine licensed in the country.

Stamping-Out: Critical Goals

- Within 24 hours of (or as soon as possible after) a premises being classified as an IP, swine will be depopulated in the quickest, safest, and most humane way possible.
- Where resources are limited, IPs will be prioritized so that those with swine having the highest potential to serve as a source of JEV for further spread by mosquitoes are 'stamped-out' first.
- Public concerns about stamping-out require a well-planned and proactive public relations and liaison campaign. Stakeholders, the public, and the international community must be involved.
- Care should be taken to consider mental health implications for owners and responders in the event a stamping-out strategy is implemented.

CONTROL AND ERADICATION IN HORSES

Horses, unlike swine, do not maintain sufficient viremia to be epidemiological important in JEV transmission. Emergency vaccination, in response to an outbreak, may be employed to protect horses from developing disease. However, there is not currently a JEV vaccine licensed in the United States.

If infected horses experience severe illness, including varying degrees of encephalitis and neurological signs, it is possible that they may need to be euthanized for welfare reasons.

SURVEILLANCE

Surveillance is essential for control and eradication of an FAD agent. The purpose of surveillance is to define the extent of the disease, detect new outbreaks, and establish disease-free zones. Surveillance activities can aid in establishing priorities in terms of control and mitigation strategies and help evaluate the efficacy of response efforts. They are also critical to maintaining continuity of business and proving disease freedom following an outbreak.

Surveillance personnel are involved in the case definition development and classification process, premises classification, and collection, assessment, and reporting of surveillance findings. Therefore, coordination between personnel conducting surveillance activities and those responsible for quarantine and movement control, biosecurity, disease reporting, and health and safety is critical for an effective response effort.

Currently there is no active surveillance for JE being conducted in the United States, either in mosquitoes, swine, equids, or birds. There are also no active

surveillance programs for JE in humans; however, the United States is involved in strengthening the surveillance capabilities of at-risk countries such as India.[20]

Passive surveillance for endemic arboviral diseases, including West Nile fever and eastern equine encephalomyelitis, could potentially identify JEV infection in a horse, human, or bird. Active arboviral surveillance in mosquitoes and sentinel bird flocks could potentially identify JEV infection in those populations.

EPIDEMIOLOGY INVESTIGATION AND TRACING

Epidemiological investigation and movement tracing during an outbreak are critical in controlling and eradicating FAD outbreaks. The epidemiological investigation involves identifying the index case, characterizing the nature of the outbreak, identifying risk factors for transmission, and developing mitigation strategies. The results of an investigation and tracing lead to identification of all IP and Contact Premises and subsequent premises classification. Tracing identifies all movements from or onto an IP. While transmission is through the bite of the mosquito, it is still prudent to trace swine and equine movements. Public health authorities have discretion over whether they will trace potentially exposed humans.

Trace-back and trace-forward information should ideally be collected for at least 42 days before the appearance of clinical signs in animals infected with JEV. Additional tracing information will be collected for movements up to the time quarantine was imposed.

Tracing

Trace Back: Identifying the origin of all swine and equine that have been brought onto an IP in order to establish the original location of their infection.

Trace Forward: The tracing of all swine, equine, and people that have left an IP and could have possibly transmitted infection to, or developed illness on, a new premises. The premises that received the animals should be investigated and kept under surveillance or quarantine.

Epidemiological investigation and tracing are the responsibility of two staff components within the Incident Command System: the Epidemiology Cell (Situation Unit, Planning Section) and the Tactical Epidemiology Group (Disease Surveillance Branch, Operations Section).

[20] Center for Global Health, Division of Global Disease Detection and Emergency Response, Centers for Disease Control and Prevention. 2012. "Global Disease Detection and Emergency Response Activities at CDC 2012." http://www.cdc.gov/globalhealth/gdder/gdd/resources.htm.

QUARANTINE AND MOVEMENT CONTROL

As discussed, the first epidemiological principle, to prevent contact between JEV and susceptible animals, can be partly accomplished through quarantine and movement control. Quarantines and movement controls of swine in a JE CA—because they maintain a high level of viremia—are critical to contain and eradicate JE. IP should be rapidly quarantined, and movement controls should be implemented for swine in the CA.

Quarantine is a type of biosecurity protocol that refers to imposing restrictions on entering or leaving a premises, area, or region where disease exists or is suspected. Quarantine stops the movement of infected animals from Infected, Contact, and Suspect Premises.

Movement control refers to activities regulating the movement of animals in an area subject to certain criteria. Movement control is accomplished through a permit system that allows entities to make necessary movements without creating an unacceptable risk of disease spread.

Each State's animal health emergency response plan should describe the implementation of quarantine and movement controls, including a permit system. USDA may impose a Federal quarantine and restrict interstate commerce from the infected States, asking the States (or adjoining countries) to provide resources to maintain and enforce the quarantine.

All decisions in regard to quarantine and movement control will be based on science-based assessments of the disease agent, routes and risk of transmission, and the interaction of other factors such as available vectors and weather.

Zone, Area, and Premises Designations

Appropriate premises designations are required for implementation of quarantine and movement control measures. The Incident Commander will work with the Disease Surveillance Branch (Operations Section) and Situation Unit (Planning Section) to establish an Infected Zone (IZ) and a Buffer Zone (BZ) within 12 hours of the identification of the index case. Once the CA (IZ + BZ) is established, quarantine and movement controls, including a permit system, will be implemented. See Attachment A for further information on zone, area, and premises designations and minimum sizes of zones and areas for JE.

Because JEV is spread by vector, the CA is likely to be at least 30 km (18.6 miles) beyond a known IP. The CA size should consider the range of a particular species of insect, if such information is available.

WILDLIFE MANAGEMENT

Wildlife management is an important component of an FAD outbreak response effort. Wild animals may become exposed, serve as a reservoir, or contribute to the transmission of the disease to domestic animals or humans either as biological or mechanical vectors. Furthermore, wild animals may potentially complicate efforts to establish freedom from disease. Wildlife management involves identifying susceptible wildlife species, determining how many species may be infected, and preventing the spread by implementing control measures.

JEV can infect various wild animals, such as mammals, reptiles, amphibians, and birds. It can also infect feral animal populations, such as feral swine and wild horses in the United States. It is important to remember that wild birds, such as herons and egrets which are native to North America, serve as reservoirs for the virus where JEV currently exists.

In the event of a JE outbreak in domestic swine and/or equids, APHIS VS will work in close collaboration and coordination with other agencies, entities, and units that have primary jurisdiction over wildlife and feral animal populations.

VECTOR CONTROL

Vector control will be a critical issue during a JE outbreak, and may be immediately instituted upon detection of JE in the United States. While mosquitoes are the primary concern for transmission, consideration must be given to the potential of other insects that may come into contact with blood, urine, or other materials. Vector control should be considered if any of the following questions can be answered in the affirmative:

- Are large amounts of virus being shed and available for potential vectors?
- Is there a high population density of potential vector species present, and are they in contact with the virus?
- Are there large populations of susceptible animals within the effective flight range of the contaminated potential vectors?

Field surveys and systematic collections of mosquitoes and other vectors may be necessary to accurately identify the potential role of arthropod vectors in spreading JE in a given area. The general concept of mosquito control during a JE outbreak is to reduce the mosquito population to insignificant levels as quickly as possible until the opportunity for JEV transmission is eliminated.

In order to effectively control the mosquito population and threat of JE transmission, both mosquito larvae and adults will need to be controlled. For further information on the Environmental Protection Agency (EPA) registered insecticides for mosquitoes, please see the following:

- For larvacides: http://www2.epa.gov/mosquitocontrol/controlling-mosquitoes-larval-stage
- For adulticides: http://www2.epa.gov/mosquitocontrol/controlling-adult-mosquitoes
- For misting systems: http://www.epa.gov/pesticides/factsheets/misting_systems.htm.

State and local laws and regulations for vector-control and insecticide use, including any relevant environmental regulations, must be considered in any vector control efforts. In addition, personal protection measures should be adhered to when using insecticides of any type.

In the United States, controlling insect vectors is primarily left to the discretion of county or municipal governments; public health departments typically take the lead on vector control issues. The following resources cover the public health aspect of vector control:

- The Centers for Disease Control and Prevention: http://www.cdc.gov/nceh/ehs/ETP/vector.htm
- The World Health Organization guide on "Pesticides and their Applications": http://whqlibdoc.who.int/hq/2006/WHO_CDS_NTD_WHOPES_GCDPP_2006.1_eng.pdf
- Center for Food Security and Public Health (English and Spanish): http://www.cfsph.iastate.edu/Infection_Control/route-specific-information-for-producers.php.

HEALTH & SAFETY

Because JE is zoonotic and a threat to public health, it is important that appropriate precautions are taken against contracting JE during a response effort. JEV is most commonly transmitted to humans through the bite of an infected mosquito, however, appropriate precautions should be observed when handling JEV in the laboratory.

Upon confirmation of JE, public health authorities have the discretion to implement appropriate public health measures, including but not limited to surveillance, prevention, and case management (as required). APHIS will work closely with public health authorities in a response.

Personal protective equipment (PPE) is fundamental to ensure personnel are protected from JE as well as other hazards during a response. Disposable or reusable outerwear may be acceptable, and all workers involved in the depopulation, transport, or disposal of JE-infected animals must be provided with

appropriate PPE. This PPE must be appropriately disposed of and/or cleaned and disinfected when leaving an IP.

Responders may also be exposed to other health hazards; prevention of adverse human health events related to emergency response efforts is important. For further information, please see the *National Animal Health Management System (NAHEMS) Guidelines: Health and Safety* and *NAHEMS Guidelines: Personal Protective Equipment*.

Mass Depopulation and Euthanasia

USDA APHIS personnel, in coordination with Incident Command, make the final decision on whether to euthanize or depopulate swine. In a JE outbreak, euthanasia or mass depopulation should be provided to the affected animals as safely, quickly, efficiently, and humanely as possible. In addition, the emotional and psychological impact on animal owners, caretakers, their families, and other personnel should be minimized. The method of depopulation will depend on facility characteristics, method characteristics (practicality, reliability, irreversibility, and compatibility), personnel considerations, carcass considerations, equipment considerations, and the environment where the animals are maintained.

Disposal

Proper disposal of animal carcasses and materials (e.g., bedding, feed) can be used to prevent or mitigate pathogen spread. The goal is to conduct operations in a timely, safe, biosecure, aesthetically acceptable, and environmentally responsible manner. Wastes requiring disposal following an FAD outbreak include carcasses, animal products, contaminated manure, litter, bedding, contaminated feed, contaminated PPE, and contaminated materials and equipment that cannot be cleaned and disinfected.

Disposal will involve more Federal authorities due to its wider reaching impact on health and the environment. USDA will coordinate with the Department of Health and Human Services, Department of Homeland Security, and the EPA to provide technical assistance and guidance, in alignment with State and local regulations.

Cleaning and Disinfection

The goal of cleaning and disinfection (C&D) is to inactivate pathogens at IP and prevent the off-site spread of pathogens. When performing C&D procedures it is vitally important to do so in the safest and most humane manner as possible. When planning a C&D task, the following components should be carefully considered: definition of the area to be cleaned and disinfected, C&D methods, personnel, regulatory permits, and materials, supplies, and equipment needed. The plan should also include the scientific rationale for C&D parameters, the process by which the premises will be certified and recorded as successfully cleaned and

disinfected, protocols for C&D, and procedures for handling damaged private property due to activities.

There are various methods of C&D that may be applied to a site. Examples include steam cleaning, pressure washing, or scrubbing by hand; shoveling, vacuuming, or sweeping out bulk materials; chemical disinfection; and physical (heat, ultraviolet light, or desiccation) methods. As previously mentioned in Table 1, JE is susceptible to organic and lipid solvents, common detergents, iodine, phenol iodophors, 70 percent ethanol, 2 percent glutaraldehyde, 3–8 percent formaldehyde, and 1 percent sodium hypochlorite. Per the National Pesticide Information Retrieval System, there are no EPA registered products for use against JEV.

For JE response, it will also be necessary to take into account vector control during the C&D process and how that necessitates changes or modifications to plans. C&D protocols, procedures, and methods, along with safety issues and precautions are more thoroughly discussed in the *NAHEMS Guidelines: Cleaning and Disinfection.*

Appraisal and Compensation

Appraisal and compensation for assets lost during a disease response effort reduce the spread of disease by encouraging owners to report suspected disease. The USDA is authorized by the Animal Health Protection Act (7 United States Code. 8301 et seq.) to pay claims to owners for any assets taken or destroyed in the course of a response effort. Title 9 of the Code of Federal Regulations (CFR) Part 53 outlines the expenses that the Department may pay for purchasing, destroying, and disposing of animals and materials in these situations. Fair market value appraisals will be provided for animals and materials destroyed to prevent the spread of an FAD. Please refer to the APHIS Livestock Appraisal, Indemnity, and Compensation website for further information.

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Attachment A Zone, Area, and Premises Designations for Japanese Encephalitis

Table A-1 and A-2 contain a summary of the zone, area, and premises designations; Figure A-1 illustrates these designations. For more information please refer to the *APHIS Foreign Animal Disease Framework: Response Strategies* (FAD PReP Manual 2-0) at http://inside.aphis.usda.gov/vs/em/fadprep.shtml (for APHIS employees), or http://www.aphis.usda.gov/animal_health/emergency_management/ (publicly available).

Table A-1. Summary of Premises Designations

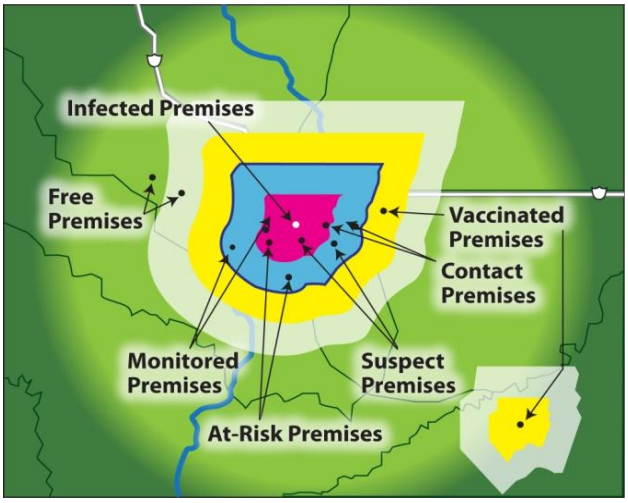
Premises	Definition	Zone
Infected Premises (IP)	Premises where a presumptive positive case or confirmed positive case exists based on laboratory results, compatible clinical signs, case definition, and international standards.	Infected Zone
Contact Premises (CP)	Premises with susceptible swine that may have been exposed to JE, either directly or indirectly, including but not limited to swine, arthropod vectors, or potential reservoir hosts from Infected Premises.	Infected Zone, Buffer Zone
Suspect Premises (SP)	Premises under investigation due to the presence of swine reported to have clinical signs compatible with JE. This is intended to be a short-term premises designation.	Infected Zone, Buffer Zone, Surveillance Zone, Vaccination Zone
At-Risk Premises (ARP)	Premises with susceptible animals, but none of those susceptible animals have clinical signs compatible with JE. Premises objectively demonstrates that it is not an Infected Premises, Contact Premises, or Suspect Premises. At-Risk Premises seek to move susceptible animals within the Control Area by permit. Only At-Risk Premises are eligible to become Monitored Premises.	Infected Zone, Buffer Zone
Monitored Premises (MP)	Premises objectively demonstrates that it is not an Infected Premises, Contact Premises, or Suspect Premises. Only At-Risk Premises are eligible to become Monitored Premises. Monitored Premises meet a set of defined criteria in seeking to move susceptible animals or products out of the Control Area by permit.	Infected Zone, Buffer Zone
Free Premises (FP)	Premises outside of a Control Area and not a Contact or Suspect Premises.	Surveillance Zone, Free Area
Vaccinated Premises (VP)	Premises where emergency vaccination has been performed. This may be a secondary premises designation.	Containment Vaccination Zone, Protection Vaccination Zone

Table A-2. Summary of Zone and Area Designations

Zone/Area	Definition
Infected Zone (IZ)	Zone that immediately surrounds an Infected Premises.
Buffer Zone (BZ)	Zone that immediately surrounds an Infected Zone or a Contact Premises.
Control Area (CA)	Consists of an Infected Zone and a Buffer Zone.
Surveillance Zone (SZ)	Zone outside and along the border of a Control Area.
Free Area (FA)	Area not included in any Control Area.
Vaccination Zone (VZ)	Emergency Vaccination Zone classified as either a Containment Vaccination Zone (typically inside a Control Area) or a Protection Vaccination Zone (typically outside a Control Area). This may be a secondary zone designation.

Figure A-1: Example Premises, Zones, and Areas

Premises



Zones and Areas

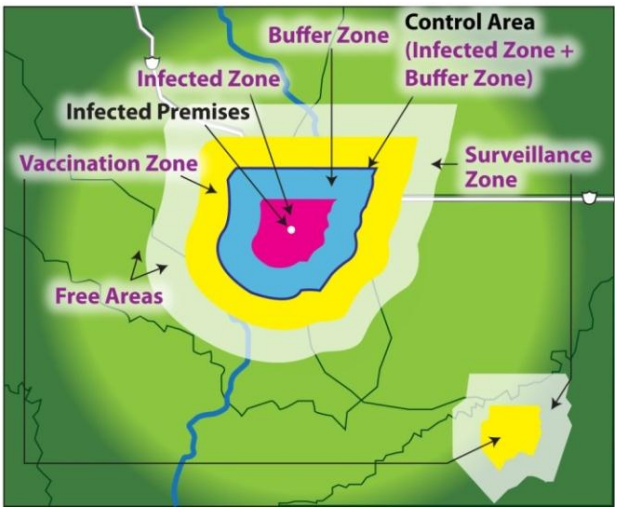


Table A-3 lists the minimum sizes of zones and areas during vector-borne outbreaks (spread by mosquitoes or culicoides).

Table A-3. Minimum Sizes of Zones and Areas for Mosquito or Culicoides Vector-Borne Diseases

Zone or area	Minimum size and details
Infected Zone (IZ)	◆ Perimeter should be at least 10 km (~6.2 miles) beyond perimeters of presumptive or confirmed Infected Premises. Will depend on disease agent and epidemiological circumstances. This zone may be redefined as the outbreak continues.
Buffer Zone (BZ)	◆ Perimeter should be at least 20 km (~12.4 miles) beyond the perimeter of the Infected Zone. Width is generally not less than the minimum radius of the associated Infected Zone, but may be much larger. This zone may be redefined as the outbreak continues.
Control Area (CA)	◆ Perimeter should be at least 30 km (~18.6 miles) beyond the perimeter of the closest Infected Premises. Please see Table 3-1 in *FAD PReP Manual 2-0* for factors to consider in determining the size of a Control Area. This area may be redefined as the outbreak continues.
Surveillance Zone (SZ)	◆ Width should be at least 20 km (~12.4 miles) but may be larger depending on the known geographic range of vector.

Attachment B Abbreviations

APHIS	Animal and Plant Health Inspection Service
ARP	At-Risk Premises
BSL	biosafety level
BZ	Buffer Zone
C&D	cleaning and disinfection
CA	Control Area
CEAH	Centers for Epidemiology and Animal Health
CF	complement fixation
CP	Contact Premises
CSF	cerebrospinal fluid
ELISA	enzyme-linked immunosorbant assay
EPA	Environmental Protection Agency
FA	Free Area
FAD	Foreign Animal Disease
FAD PReP	Foreign Animal Disease Preparedness and Response Plan
HI	hemagglutination inhibition
IP	Infected Premises
IZ	Infected Zone
JE	Japanese encephalitis
JEV	Japanese encephalitis virus
MP	Monitored Premises
NAHEMS	National Animal Health Emergency Management System
NSU	National Surveillance Unit
OIE	World Organization for Animal Health

PHK	primary hamster kidney
PPE	personal protective equipment
RNA	ribonucleic acid
RT-PCR	reverse transcriptase-polymerase chain reaction
SMEDI	stillbirth, mummification, embryonic death, and infertility
SP	Suspect Premises
SZ	Surveillance Zone
TDD	telecommunications device for the deaf
USDA	United States Department of Agriculture
VN	virus neutralization
VP	Vaccinated Premises
VS	Veterinary Services
VZ	Vaccination Zone
WNV	West Nile virus