APPENDIX B

DPH EEE RISK ASSESSMENT, RISK CATEGORIES, STRATEGY FOR VECTOR CONTROL
(from the Vector Control Plan to Prevent EEE)

VI. RISK ASSESSMENT

The potential risk for EEE disease in humans is categorized into one of four levels according to an assessment of EEE surveillance data from the current and previous year. The risk levels are (1)Low (2)Moderate (3)High and (4)Public Health Emergency. Under Risk Levels 2, 3 and 4, the characterization of risk includes a definition of areas of concern. The concept of "area of concern" is important in defining the magnitude of the EEE risk and selecting appropriate intervention options. There are three components within the conceptual construct of area of concern: study area, risk area and treatment area.

(1) The study area is the geographical area where most human and equine EEE cases in Massachusetts have occurred. This area is shown in Figure 3 and includes Plymouth, Norfolk, Suffolk, Bristol, Middlesex and Essex Counties. Personal protection measures are emphasized in this area through a public information campaign that intensifies at each level of risk.

(2) The risk area is the geographical area where most of the human EEE cases have occurred. This area is shown in Figure 4 and includes Plymouth, Bristol and Norfolk Counties, and parts of Middlesex and Suffolk Counties. Vector control efforts may be implemented by state agencies or Regional Mosquito Control Districts within this area. Vector control efforts may be extended outside of this area, if surveillance data indicate the probability of multiple human EEE cases occurring outside the area of historical disease prevalence.

(3) Treatment areas are defined by EEE surveillance data and are used to guide vector control efforts. The basic cell is defined by a mosquito trap site and is approximately 100,000 acres. These treatment cells are calculated to be the set of "best-fit" polygons that represent the areas around trap sites. The area for treatment will be defined by the GIS polygon inclusive of all towns with more than 20% of their area within the unit. Vector control intervention will be dependent upon viral isolation from mosquito pools trapped at the DPH site. The treatment area for a positive EEE virus isolation from a horse or human is defined by a circle approximately 2 miles in radius around the case. Within a treatment area, larviciding is recommended in areas where significant

levels of vector species larvae are present, and treatment would be expected to reduce adult emergences in proximity to large numbers of people. Adulticiding of a treatment cell is recommended if predetermined risk indices are met and significant numbers of vector species adults are present.

At a Moderate or High level of EEE risk, vector control is considered within an area following identification of EEE virus in the environment. Following a positive finding supplemental surveillance is done to assess the need for a vector control intervention. Additional trapping will be implemented in the treatment area to determine the age structures and population abundance of vector species. Larval surveys may also be initiated after significant rainfall events.

EEE occurs disproportionately by area within eastern Massachusetts. The human cases of EEE by county have been 25 in Plymouth, 19 in Norfolk, 13 in Middlesex, 9 in Suffolk, 5 in Bristol, 1 in Essex, 1 in Barnstable, and 1 in Hampden. A disease prevention strategy must respond to this disproportionate distribution of risk by providing supplemental mosquito control funding (and/or state or federal assistance delivered through independent contractors) for high risk areas and by coordinating efforts among Mosquito Control Districts that share common risk areas. The epicenter of EEE appears to be the contiguous area where Plymouth, Norfolk and Bristol Counties join. This area should be the primary target of coordinated mosquito control efforts under the direction of a state office. In the event that fiscal, staff, and equipment resources available to regional mosquito control districts are insufficient, the state must be prepared to assist in the effective control of mosquitoes to help prevent or minimize human EEE cases.

RISK CATEGORIES

(1) LOW - A LOW LEVEL OF EEE RISK exists if all of the following conditions are met:

Current Season

1. EEE virus isolates in *Cs.melanura* <10
2. Population of *Cs. melanura* below long-term mean

Previous Season

1. No human or horse cases
2. *Cs. melanura* below long-term mean
3. EEE virus isolates <20

At this level surveillance activities are routine and supplemental control efforts are not recommended. Mosquito control efforts should be standard in accordance with established plans for integrated pest management (IPM). IPM is an ecologically based strategy for managing insect populations with the goal of keeping pest levels below predetermined threshold levels. Mosquito Control District (MCD) IPM programs may include source reduction, ground or truck spray adulticide, larvicide, and other control activities in response to human annoyance thresholds (HATs) as determined by the MCDs operating under the State Reclamation and Mosquito Control Board.

(2) MODERATE - A MODERATE LEVEL OF EEE RISK exists if any of the following conditions exist:

Current Season

1. EEE virus isolates from *Cs. melanura* >10
2. *Cs. melanura* populations approaching long-term mean
3. 1-2 presumptive or confirmed horse cases

Previous Season

1. 1-2 human cases or 2-4 horse cases
2. *Cs.melanura* population above the long-term mean
3. EEE virus isolates from *Cs. melanura* >20

At this level, mosquito control interventions should be directed only against those species suspected as epidemic vectors (capable of EEE virus transmission to humans). Regional mosquito control efforts should be intensified only in EEE virus positive treatment areas. These efforts may include larviciding and ground or truck spray adulticiding based upon surveillance data that indicates significant larval and/or adult populations of bridge vector species.

(3) HIGH - A HIGH LEVEL OF EEE RISK exists if any of the following conditions exist:

Current Season

1. Confirmation of 1 human case
2. 3 or more presumptive or confirmed horse cases
3. *Cs. melanura* population above the long term mean and MIR in Cs.melanura >1
4. EEE virus isolate from bridge vector species

Previous Season

1. 2 or more confirmed human cases or 5 or more presumptive or confirmed horse cases.

These indices trigger intensive surveillance of bridge vector species and recommendations for state-funded vector control interventions which may include ground or targeted aerial larviciding and/or adulticiding. Treatments would be undertaken only in EEE virus positive treatment areas, defined by EEE virus isolates and horse or human cases, as surveillance of bridge vector populations indicate.

(4) PUBLIC HEALTH EMERGENCY - DPH will forward a recommendation immediately to the Governor's Office to declare a PUBLIC HEALTH EMERGENCY in the event that any of the following conditions exist:

Current Season

1. 2 human cases are confirmed
2. More than 10 horse cases are confirmed

Surveillance data indicating that multiple human cases of EEE will occur without intervention

These criteria will be considered sufficient for a recommendation that an emergency be declared, if they occur at a time when seasonal and biological conditions present a continuing high risk of EEE human disease. The declaration of an Emergency may trigger state supported mosquito control efforts using wide area aerial application of mosquito larvicide or adulticide. A recommendation for a wide area aerial adulticide application will be made only if surveillance data indicate a risk of multiple human cases and biological conditions are favorable for continuing risk. When such control strategies are recommended, treatment areas will be defined by DPH surveillance data. Areas targeted for aerial pesticide application will immediately be notified and all media sources utilized to alert residents to the timing and scope of the application. Environmental monitoring will be done before and after treatment and rare and endangered species habitat excluded from the spray zone in affected areas. In addition a 500-1000 foot setback will be observed when spraying around water bodies. The objective of this option is to cause a significant reduction in all species capable of EEE transmission. This intervention is successful if the target species are temporarily reduced thereby interrupting the amplification of the virus within its avian reservoir. The timing of this late season option is critical and is intended to be a one-time intervention.

VII. STRATEGY FOR VECTOR CONTROL

A vector control plan must be safe, economical, minimize environmental effects, and minimize the risk of human EEE disease. To achieve these ends, the plan must be, to the maximum extent possible, geographically and vector species specific. Vector control measures are chosen according to species, seasonal and climatic conditions, and vector life stage indices.

Three options will be available for vector control: larviciding; targeted small scale adulticiding; and wide-area aerial adulticiding; with specific activities chosen by analysis of surveillance data. Treatment areas will be defined by mosquito trap sites and/or human/equine case locations. Within a treatment area, the use of larviciding or adulticiding interventions will be guided by additional field information and surveillance data to limit the area of intervention to the extent possible, taking into account the uncertainty of risk data. All state supplemented vector control interventions will be done under the authority of Regulation 304-CMR. Section 50.08 (3)(a).

The number of mosquito species that potentially could serve as epizootic vectors of EEE is extensive; however the three species most often thought to be responsible for human and equine infection are *Coquillettidia perturbans*, *Aedes vexans* and *Aedes sollicitans* (Tsai 1991). Recent studies suggest that *Anopheles* species and *Culex salinarius* should also be considered as epidemic EEE vectors (Edman et al 1993, Vaidyanathan et al. 1997). An historical analysis of the epidemidology of EEE in Massachusetts and mosquito abundance and isolation data indicate that *Ae. vexans*, *Ae. canadensis* and *Cq. perturbans* are likely vectors involved in human disease transmission in Massachusetts. *Ae. sollicitans* may also be a vector for cases located closer to the coast, and may be targeted in areas where known human and/or equine cases have occurred.

Cq. perturbans, a permanent water species, breeds in cattail marsh areas, common in the disturbed sections of wetlands. This species has one generation per year, emerging by mid June and reaching peak populations by early to mid July. An aggressive human biter, *Cq. perturbans* presents a difficult control problem because its larvae develop attached to the roots of emergent vegetation in permanent marsh areas. The insect growth regulator methoprene in the form of slow release Altosid formulations has proven to provide effective larval control of this mosquito (Sjogren et al. 1986). This chemical is relatively nonpersistent in the environment and exhibits morphological rather than direct toxic action by interfering with larval development.

Aedes vexans, *Aedes sollicitans*, and *Aedes canadensis*, are reflood mosquitoes whose abundance levels are directly related to rainfall and floodwater or moon tide events sufficient to flood intermittently flooded oviposition areas. All of these species may exhibit peak populations mid to late summer concurrent with peak EEE virus activity in birds and may be treated at the larval stage using the biological control product, *Bacillus thuringiensis* var. *israelensis* (Bti). The success of such applications, may be hampered, however, by the small treatment window available due to rapid larval development and by the difficulty of application through the dense canopy and thick underbrush of late summer. Bti is a natural microbial agent toxic to most mosquito and blackfly larvae. It is non-toxic to bees but some mortality to other Diptera has occurred at mosquito-control application rates. In all EEE vector interventions standardized larval surveys will be conducted pre and post application.

Aedes vexans is the most predominant summer reflood mosquito in Massachusetts. The appearance of this species is dependent on the frequency and spacing of major rains. Broods have been observed from the latter part of June throughout the summer and into the fall. Although the window for effective larval treatment is narrow due to the rapid development of this species, *Bti* applications have been used successfully for control.

Aedes sollicitans breeds in the high salt marsh that is normally only flooded by moon tides at the full and new moon. *Aedes sollicitans* is an aggressive biter know to travel great distances from its breeding habitat. This species can be effectively controlled with *Bti* and treatment is made easier by the predictability of its life cycles. *Aedes canadensis* is primarily a univoltine species that appears from late spring through mid summer. A second brood can develop in early fall if rainfall is sufficient. These mosquitoes develop in temporarily flooded woodland depressions and vernal pools that are often inaccessible, particularly late in the summer, due to heavy underbrush making ground control difficult if not impossible to accomplish. Due to the heavy tree canopy and dense underbrush of this habitat, aerial larval control of *Aedes canadensis* is also very difficult.

Anopheles mosquitoes inhabit permanent water, and may be found along the edges of slow moving streams. In the latter part of the summer they may also be found in temporary pools and puddles caused by summer rainfall. *Culex salinarius* is classified as a permanent water species. This species is multivoltine with peak populations occurring late in summer. *Cx. salinarius* is an active human biter and although mammalophagic, it is more likely than other potential epidemic species to feed on birds thus increasing its chances of a playing a role in EEE virus transmission (Vaidyanathan et al 1997). The larvicide *Bacillus sphaericus* has been found to be effective against *Culex* species. *Bacillus sphaericus* is a naturally occurring bacterium with the same mode of action as Bti but with an even more narrow toxicity range. This larvicide is more effective than Bti in the highly organic water favored by *Culex* species. The spores of this bacterium are slowly removed from the water column and *B. sphaericus* may undergo limited recycling in certain environments thereby increasing its availability to target organisms. Granular formulations of *B. sphaericus* have been found to work effectively against Anopheles species (Arrendondo et al. 1990). Altosid formulations have also been used successfully as larval control agents.

Small-area, targeted, ground or aerial adulticiding with ULV malathion or resmethrin may also be utilized if specific risk conditions are met. This effort will be aimed at all potential vector species in the target area where population and life stage studies indicate treatment is required. Wide-scale aerial adulticiding may only be employed during a public health emergency if it is determined that use of such treatment is needed to prevent further human disease transmission.

An effective adulticide provides a sufficient reduction in vector species such that there is insufficient time for reinfection of a subsequent brood of vector species before the end of the mosquito season. Late season risk following a wide area intervention is usually limited by lack of virus availability in avian species, the low probability of significant numbers of infectious human biting mosquitoes surviving, and cooler weather that limits the activity of mosquitoes.

All state supplemented aerial adulticide treatments will use ULV malathion. A comprehensive review of aerial applications of insecticide for mosquito control concludes that ULV applications are efficacious, cost effective and can be used effectively over dense foliage or open housing (Mount et al. 1996). Malathion has been chosen because of its effectiveness against adult mosquitoes and its relative safety for humans and other vertebrates (Edman and Clark 1990). The efficacy of all adulticiding treatments will be determined by a comparison of pre and post-spray DPH trap site mosquito abundance levels.

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