TORONTO STAFF REPORT

June 12, 2003

To: Board of Health

From: Dr. Sheela V. Basrur, Medical Officer of Health

Subject: Enhanced Mosquito Control Activities to Prevent and Control West Nile virus (WNV)

Purpose:

To outline factors that will be considered in decisions regarding the control of adult mosquitoes to reduce the risk of human transmission of West Nile virus (WNV) in the City of Toronto in 2003.

Financial Implications and Impact Statement:

The budget for the 2003 WNV program, as approved by City Council, provided for a basic level of mosquito control activities including the control of mosquito larvae in city-owned catch basins on the road allowance. The enhanced mosquito control activities that are described in this report were not part of the base plan and will require the additional allocation of resources by the City. These resource requirements are outlined in a parallel report to the Board of Health "West Nile virus Update and Budget Implications for Enhanced Mosquito Control Activities for the 2003 West Nile virus (WNV) Program".

Recommendations:

It is recommended that:

(1) the Board of Health endorse the process for decision-making on enhanced mosquito control, including adult mosquito control, to prevent and control West Nile virus (WNV) as outlined in this report;

(2) the Medical Officer of Health forward copies of this report to the members of the West Nile virus Advisory Committee for their review and comment to the Toronto Interdepartmental Environment Committee;

(3) the Board of Health forward a copy of this report for information to City Council through the Economic Development and Parks Committee, the Planning and Transportation Committee and the Works Committee;

(4) the Board of Health forward copies of this report to the Ontario Public Health Association, the Association of Local Public Health Agencies, the Ontario Ministry of Environment and the Ontario Ministry of Health and Long Term Care for their information; and

(5) the appropriate City Officials be authorized and directed to take the necessary action to give effect thereto.

Background:

At its meeting of November 18, 2002, the Board of Health requested that the Medical Officer of Health (MOH) report back on a protocol for the application of pesticides for mosquito control to prevent the spread of West Nile virus. In the January 20, 2003 report to the Board of Health entitled "Protocol for the Control of Mosquito Larvae to Prevent and Control West Nile virus (WNV)", the Medical Officer of Health outlined an integrated pest management (IPM) framework for the mitigation of human health risk from WNV. The framework identified three tiers of intervention:

(1) environmental management and public education;
(2) use of biological or chemical pesticides to control mosquito larvae; and
(3) the control of adult mosquitoes (Table 1).

The use of adulticides is to be considered as a last resort, only after Tier 1 and Tier 2 interventions have not adequately reduced the human health risk from WNV.

Table 1: Integrated Pest Management (IPM) Framework for WNV

Priority	IPM Component	Examples
Tier 1	Environmental Management & Public Education	Source reduction by environmental modifications Surveillance and monitoring of WNV activity Personal precautions, mosquito avoidance
Tier 2	Larval Mosquito Control	a) Non Chemical Methods Introduction of natural enemies (e.g. dragonflies) Cleaning of Catch Basins
		b) Lowest Impact Larvicides Bacterial agents (e.g. Bti) Hormonal agents (e.g. Methoprene)
		c) Other Larvicides e.g. Fenthion, Chlorpyrifos
Tier 3	Adult Mosquito Control	Adulticides e.g. Malathion

The current report details factors that will be considered before adult mosquito control activities or Tier 3 control measures in the protocol are implemented.

Comments:

The West Nile virus (WNV) is transmitted between birds and between birds and humans by the bite of a mosquito. Control of mosquito populations is therefore the main method that can be used to reduce the spread of WNV within the bird population and prevent or minimize the eventual spill over into humans.

Mosquito populations are best controlled through an integrated pest management (IPM) approach. An IPM approach gives priority consideration to methods that reduce the reliance on pesticides and have the least adverse impact on health and the environment. When pesticides are used, preference is given to the least toxic alternative available. The Toronto Public Health (TPH) Protocol for the Control of Mosquito Larvae outlined three tiers of control measures. Tier 1 includes surveillance to gather information on mosquito and WNV activity to inform decisions on mosquito control activities. It also uses public education and environmental management strategies to reduce mosquito populations and encourage the adoption of personal protection measures. If these methods are not sufficient or effective, Tier 2 methods are then adopted to supplement Tier 1 approaches. These are the use of biological or chemical agents, with preference given to those agents that have the least adverse impacts on health and the environment. It is possible that, even when Tier 1 and 2 measures are fully implemented, there may be a continuing high risk of transmission of WNV to humans. Under such circumstances, the judicious application of adulticides may be necessary to try to reduce this risk.

Experience in localities that have long-standing mosquito control programs shows that an integrated pest management approach is cost effective, reduces the use of pesticides and has fewer adverse environmental and health impacts than mosquito control that relies primarily on the control of adult mosquitoes. There are some nuisance mosquito control programs that rely only on the use of larvicides. However, the recommended public health practice across the world is to retain adult mosquito control at least as an emergency measure.

Any decisions to implement or to refrain from implementing adult mosquito control measures will be based on: thorough analysis of all surveillance information; consultation with local, regional and other experts; and best professional judgement by the Medical Officer of Health. The decisions, practices, and concerns of adjacent jurisdictions will also be taken into account, along with applicable provincial requirements. The area to be sprayed will be kept as small as possible and the lowest possible number of applications will be made in order to achieve adequate mosquito control.

Regulatory Requirements:

Ontario Regulation 199/03 Control of West Nile virus made under the Health Protection and Promotion Act (Attachment A) requires the Medical Officer of Health to undertake a local risk assessment to determine the level of action required by a municipality to reduce the human health risk from WNV. These requirements include surveillance, education, and mosquito control activities. The regulation also requires the Medical Officer of Health to report on any adverse impacts to human health or the environment that have occurred due to mosquito control actions.

To address this, Toronto Public Health will establish a reporting mechanism with physicians and hospitals to assist in gathering data on any adverse human health impacts should an adulticide program be required. The mechanisms that will be put in place for this reporting are still under consideration and will be challenging, especially due to the operational burdens placed on hospitals, physicians and public health as a result of SARS. It should be noted that the Regulation does not provide a parallel duty on physicians, hospitals or laboratories to report these adverse effects to the local Medical Officer of Health.

The regulation identifies triggers to guide the level of intervention needed based on a local needs assessment. This includes the use of pesticides to control larval and adult mosquitoes. Specific guidance for the implementation of this regulation is still under development by the Ministry of Health and Long-term Care (MOHLTC). However the regulation states that if the virus is found in a bird, mammal or mosquitoes, and there is a high risk of WNV transmission to humans, then adult mosquito control is to be considered. Adult mosquito control is also to be considered when there is a cluster of human cases of WNV, or when human cases continue to occur.

While a permit is required for the use of larvicides because pesticides are applied directly to a body of water, there is no such requirement for adulticides. Pesticides to control adult mosquitoes must be applied by a licensed applicator and are subject to Ministry of the Environment public notification requirements. If the Medical Officer of Health determines that there is a need to apply an adulticide, the public will be notified of such application through the local newspapers at least 48 hours in advance. Information about the spray program will also be available on the TPH Web site and WNV information line.

Criteria for Enhanced Mosquito Control:

The assessment of the health risk of WNV and the decision to enhance mosquito control activities, including the use of adulticides, is very complex. It involves the analysis of data such as reports of dead birds, mosquito populations, types of mosquitoes, identification of WNV in birds, mosquitoes, mammals and humans, the distribution and extent of WNV in neighbouring health units and other parts of North America, the time in the mosquito season, and the weather. Current knowledge is insufficient to accurately determine the level of risk in the community; thus decisions for enhanced mosquito control will consider all the available data and be based on best professional judgement. Any decision to control adult mosquitoes will be made by the Medical Officer of Health in consultation with the neighbouring health units, the Chief Medical Officer of Health, and appropriate experts.

Based on the current understanding of WNV, a critical mass of infected mosquitoes must be present close to a human population in order for transmission of WNV to humans to occur. However, the exact level of mosquito activity that corresponds to a risk to humans is still not known. Therefore it is not possible to establish mosquito control guidelines based on a simple trigger such as the number of mosquitoes caught in a trap on one or more nights. Mosquito data for 2003 will be compared to 2002 and tracked over time and geography. All of this information can provide a relative indication of the risk of WNV. Sufficient mosquito surveillance can assist in the evaluation of the effectiveness of mosquito control measures. This will indicate if the numbers of mosquitoes, including infected mosquitoes, have been successfully reduced, which would suggest a reduction in the risk of transmission of WNV to humans.

Review of 2002 surveillance data from various areas in North America (for example, New York City, Chicago, and Halton Region) show the following pattern: a sharp increase in mosquito populations in July is followed by a peak in dead bird sightings which is then followed by another peak in mosquito numbers and an increase in the number of human cases. As a result, a sharp increase in mosquito populations and dead bird sightings can indicate a likelihood that there is an increased risk of transmission of WNV to humans. Thus, this can suggest the need for enhanced mosquito control activities.

The most useful indicators of elevated human health risk are summarized in Table 2 below.

Table 2: Indicators of WNV Risk to Humans

Indicator	Usefulness	Summary
Number of Adult Mosquitoes	Excellent	A spike in the number of adult mosquitoes tends to appear about two weeks before the appearance of human cases. High numbers of adult mosquitoes, particularly of the critical species, would suggest the need to review mosquito control activities and consider measures to enhance them.
Proportion of WNV-Positive Mosquitoes	Good	An increase in the proportion of WNV-positive adult mosquitoes suggests increased viral activity in the mosquito population and thus increased risk to human health.
Dead Bird (Crow) Sightings	Fair	A spike in the number of dead bird sightings tends to appear before the appearance of human cases. However, the increase in sightings could be due to greater awareness of the need to report dead birds due to WNV stories in the media. Dead crow sightings are used in Southern Ontario health units as an early indicator of WNV activity in an area.
Number of Human Cases	Poor	Since there is a 3-14 day incubation period between the time of infection and the onset of symptoms, followed by possible time lags in diagnosis and reporting, reliance on human data to make mosquito control decisions can result in mosquito control being initiated after the peak period of transmission has occurred.

Enhanced Intervention:

It is possible that the mosquito control measures identified in the City’s 2003 West Nile virus Prevention and Control Plan will not adequately reduce the risk of WNV. In the event that surveillance data indicates that the risk of WNV to humans remains high, the Medical Officer of

Health will need to strengthen mosquito control activities in the City. First consideration will be given to enhancing the following approaches:

(1) strengthened education and outreach on measures to reduce mosquito-breeding sites and personal protection;
(2) enhanced surveillance of mosquito breeding sites, including inspection and enforcement;
(3) expanded control of mosquito larvae in catch basins and possible extension of this program to other bodies of standing water; and
(4) declaration of an emergency under the Ontario Emergency Management Act to facilitate the mobilization of resources for enhanced mosquito control activities.

Decision to Control Adult Mosquitoes:

There is only a small window of opportunity (about 5 days) for making a decision to control adult mosquitoes in focussed areas if this is to result in a substantial decrease in the risk of WNV in humans. It is therefore important for the Medical Officer of Health to make this decision in a timely fashion using all available data. As mentioned above, this decision will be made in collaboration with other health officials and experts in the field. Should the data indicate that in spite of all efforts taken, the risk of WNV to humans remains high, then the Medical Officer of Health will consider the control of adult mosquitoes in areas where it is likely to be effective in reducing the risk of human disease. Adult mosquito control will be limited to areas where surveillance shows a high number of adult mosquitoes, presence of WNV and a high likelihood of transmission of WNV to humans.

Environmental and Health Impacts of Adult Mosquito Control:

Health Canada and the Pest Management Regulatory Agency (PMRA) recommend that the pesticide that is selected for mosquito control be one with the most complete health and environmental data available and which has been recently reviewed. Malathion is the pesticide that is registered for use to control adult mosquitoes in Canada that meets these criteria, and thus is the agent that will be used in Toronto in the event that it becomes necessary to control adult mosquitoes in 2003.

The recommended way to spray malathion for mosquito control is through an ultra-low volume or ULV application. This greatly reduces the amount of pesticide used and eliminates the use of solvents. The amount of malathion used to control mosquitoes is much lower than what is needed for the control of other pests. Exposure calculations by the U.S. Environmental Protection Agency show that when used for mosquito control, the level of exposure to malathion is thousands of times lower than health-based exposure limits, even taking into account the potentially greater sensitivity for children. If people stay indoors, close windows and ensure that all air vents are closed, the exposure to malathion is even lower.

There have been a few reports of adverse health effects in people who have been exposed to malathion during or shortly after application. Where spraying for mosquito control occurs, the public may be exposed if they are outdoors during actual spraying, or if they touch contaminated plants, soil, turf or other outdoor surfaces, or eat unwashed contaminated garden produce within a day or so after spraying. For example, one case report indicated a man developed a rash on areas of his skin that had contact with a pool cover he had removed after spraying malathion on it for mosquito control. In most cases of ULV applications of malathion for mosquito control, there have been no reports of adverse health effects that were linked to exposure to pesticides.

There is little information on the potential effects of malathion to pets. Malathion is used in some products to control fleas on cats and dogs. To reduce exposure and the chance of adverse effects, pets should be kept inside during the application of a pesticide. Some pesticide residues may be present on outdoor surfaces after spraying. A few studies on other chemicals suggest the amount of pesticide transferred to skin decreases with more time after spraying (and very little transfers 24 hours after spraying); is less on dry skin compared to wet skin; and is less from porous surfaces compared to non-porous ones.

Malathion is very toxic to beneficial insects such as bees that may be exposed either directly or to residues present on vegetation. It is also highly toxic (both acutely and chronically) to aquatic organisms (fish and aquatic invertebrates) at relatively low concentrations. There have been many reports of ecological effects (e.g. substantial fish, invertebrate and frog mortality) related to urban use of malathion. Therefore, care must be taken to prevent the malathion spray from contaminating natural bodies of water.

While most of the malathion released remains close to areas of application, there is the possibility that some is transported away by rain runoff, fog, and wind. Spray drift is greater with aerial application than with ground application.

Malathion breaks down to other chemical compounds with exposure to sunlight, water and the bacteria in soil and water. Since it breaks down relatively rapidly (the half-life in soil being 1 - 2.5 days), malathion is unlikely to reach groundwater in significant amounts. More information on malathion and its effects on health and the environment is found in Attachment B.

The Effectiveness of Pesticides in Reducing Mosquito Populations:

The effectiveness of adult mosquito control and its associated ability to reduce health risks from WNV is often questioned. In part, this depends on the pesticide used and the type of mosquitoes that are controlled, as different species of mosquitoes vary in their susceptibility to various products. Before a product is registered for a certain use, the manufacturer must provide efficacy data. Adulticides can reduce mosquito populations by over 90%. However mosquito populations can recover quickly. Aerial spraying is more effective than ground-based applications because it results in more even distribution of the pesticide, however there is a greater chance that the pesticide will drift into non-targeted areas. In dense foliage or open housing, satisfactory control may need higher concentrations (2 – 3 times); however, this can be above rates recommended on the label. Effectiveness is also dependent on the time spraying occurs. Although the best time to spray will vary according to the habits of the specific mosquito species, generally the best time to spray is two hours around dusk or dawn when mosquitoes are at their peak flying activity.

Many studies have shown that spraying of adulticides kills adult mosquitoes. In general, the abundance of adult mosquito populations is reduced following treatment but typically mosquito populations are suppressed for only 7 to 10 days. As a result, adulticides may have to be reapplied, in order to reduce mosquito populations below the threshold (or critical mass) at which virus transmission to humans occurs. The U.S. Centers for Disease Control and Prevention guidelines indicate that two to three applications spaced three or four days apart may be needed to reduce Culex mosquitoes sufficiently.

Effectiveness of Adult Mosquito Control in Controlling West Nile Disease:

Few studies have been performed that clearly demonstrate that application of adulticides decreases the incidence of human infection with diseases carried by mosquitoes. The degree of effectiveness of adult mosquito control for prevention of WNV disease in humans is uncertain: it is unknown what proportion of mosquitoes must be controlled to reduce the transmission of WNV; spraying mosquitoes is the least efficient method of mosquito control; spraying adult mosquitoes is only effective for a short period of time as the pesticide affects only those mosquitoes airborne at the time of the spraying; buildings and other physical barriers limit the success of spraying; spraying adult mosquitoes may have toxic effects on some humans and ecosystems (e.g. honey bees, butterflies and other beneficial insect populations); and at this time, it is unclear whether spraying adult mosquitoes reduces the risk of WNV infection in humans or horses.

In 1999 there were over 60 cases of WNV in New York City. In response, New York City implemented an aggressive mosquito control program that included the use of adulticides. Since then, the number of human cases has remained much lower, with 29 cases experienced in 2002. By contrast, the City of Toronto had 127 confirmed cases reported in 2002. This supports the hypothesis that mosquito control is a useful tool to reduce the risk of WNV. However, it is also possible that the decrease in WNV could be due to other factors such as the natural cycle of the disease, the build-up of immunity in human populations, or the other components of New York City’s WNV control program, which includes more extensive surveillance and larval control than provided for in Ontario.

One reason municipalities use adult mosquito control is because it can easily provide community-wide control of mosquitoes. Although addressing breeding sites is preferable, it can be difficult to ensure that residents and businesses undertake the proper and complete measures to reduce mosquito breeding.

Challenges to the Implementation of Adult Mosquito Control:

One of the largest challenges to adult mosquito control is to balance the potential benefits to human health from reduced incidence of WNV with the potential harm to human health and the environment from the use of adulticides. There is significant uncertainty in the assessment of the benefits and risks on human health related to WNV as well as uncertainty in the potential adverse impacts of pesticide use on human health and the environment.

In addition, the resources available for surveillance in Toronto and other health units may not be comprehensive enough to target adulticiding activities to areas at highest risk. For example, it is not certain that the current allocation of only 15 permanent mosquito-trapping sites across the 632 Km^2 of the City will allow Toronto Public Health to pinpoint the areas of increased viral activity in mosquitoes. An external report prepared for Toronto Public Health in 2001 identified that at least 40 permanent trap locations across Toronto would be needed to provide sufficient data for WNV surveillance. As a comparison, New York City (645 Km^2) and Chicago (600 Km^2) are monitoring adult mosquitoes at 70-80 locations.

In addition, the intensity of WNV testing in birds is also much lower than in the U.S. Toronto is limited to a maximum of four birds per week for WNV testing and there is the possibility that, like last year, testing for WNV in birds from Toronto could end before the height of the WNV season due to limited laboratory capacity. Without the capacity to test more birds for the virus, the reliability of the sighting of dead birds as an indicator for areas that need mosquito control is questionable. Additional surveillance data beyond that presently supported by MOHTLC is needed to ensure that the use of adulticides is limited to areas that are at high risk.

The increased capacity for WNV testing in humans in 2003 will help reduce the delay in reporting of WNV cases. This will help monitor the extent of the disease in humans. However, these data must be used with caution when assessing the need to control mosquitoes, as exposure may have occurred up to 14 days prior to the onset of symptoms. Although a cluster of cases might indicate an area at high risk, it is not always possible to know for certain where a person acquired their infection, since people can be exposed to WNV in a variety of settings (e.g. in a local or regional park, at the cottage, while camping outdoors or on their own property). This is especially true now that WNV is present in large parts of North America.

In 2003, human case definitions have become more complex. There are three main categories reflecting severity: WNV Asymptomatic Infection, WNV Fever, and WNV Neurological Manifestations. Since the occurrence of a human case can indicate a need for adult mosquito control under the new provincial regulation, the complexity of the case definitions makes the significance of available human case data more difficult to interpret (see Attachment C).

Considering the time needed to diagnose and report a case of WNV, there will always be a lag in the availability of data for risk assessment. Relying only on human data to trigger adult mosquito control can result in adult mosquito control that may do little to prevent subsequent human cases. It may also prompt calls for adulticiding when mosquito populations are already on the decline at the end of the season.

In addition, there are a number of logistical challenges that adult mosquito control would face. Spraying for adult mosquitoes reduces mosquito populations for a short time. Therefore, it is often necessary to apply adulticides two or three times to the same area in order to ensure adequate control. Another challenge is the capacity needed to cover an adequate area in time. Using provincial guidelines that suggest adult mosquito control within a 3-km radius of a human case, it is estimated that it could take more than 20 hours for one truck to spray such an area. In the event of a large number of human cases, the provincial guidelines would suggest that a much larger area would need to be sprayed. If there are no overlaps, more than 20 such circles would be needed to cover the City of Toronto. There is insufficient capacity for this level of effort in Toronto, let alone Ontario.

People with Environmental Sensitivity:

The Chief Commissioner of the Ontario Human Rights Commission has advised municipalities and the Ministry of Health and Long-Term Care that they need to take into consideration that "environmental sensitivity" (also known as multiple chemical sensitivity) is considered a disability in the Commission's "Policy and Guidelines on Disability and the Duty to Accommodate" (see Attachment D). As such, municipalities will have to address this when implementing their mosquito control programs. Local Medical Officers of Health have requested the MOHLTC to advise public health units regarding this issue.

The City Solicitor has also been consulted on this matter. The Ontario Human Rights Code recognizes that discrimination against persons with disabilities is not always grounded in negative stereotypes but rather can be based on society's failure to accommodate actual differences. It is well established that equality may sometimes require different treatment, which may include providing separate or specialized services for those persons. Positive steps must be taken to ensure that disadvantaged groups benefit equally from services offered to the general public.

In the case of the use of pesticides to control adult mosquitoes, the service provided is intended to be beneficial to everyone living in the municipality. However, it may have unintended effects on persons with environmental sensitivities, potentially resulting in "adverse effect" discrimination.

Given that persons with environmental sensitivities may suffer an adverse effect from the adult mosquito control service, some form of accommodation is required. The actual nature of the accommodation is determined on a case-by-case basis depending on the person involved and the circumstance in each situation. Adult mosquito control is a new area that has not been adjudicated by the courts. It is not clear what the duty is in this case. An appropriate level of balancing is required between the protection of the general public and the protection of those persons who may suffer adverse effects. It is not only persons with environmental sensitivities that may suffer such an adverse effect but also people with asthma and other respiratory ailments.

There is a continuum of potential methods of accommodation. At minimum, the public notification requirements set out in Regulation 914 of the Pesticides Act and the Ontario Ministry of the Environment guidelines are required. This may provide an appropriate level of accommodation. The service provider could consider additional accommodation through a registry whereby persons who are listed on the registry are given personal advance notification of the adulticide use. The establishment of a registry is one way in which cities such as Ottawa and Winnipeg are dealing with this issue. Should the City of Toronto wish to consider a registry, the nature, scope, implementation, privacy and financial implications of such a registry will need further discussions and should be the subject of a separate report.

In summary, there is a duty on the service provider of the adulticide application to accommodate persons with environmental sensitivities in accordance the Ontario Human Rights Code. Since this a new area, with no decisions by courts or tribunals, it is difficult for City Legal to advise on what appropriate accommodation would be in this circumstance. It is an area that is not free from doubt and is continuing to develop. It may be that the public notification requirements under the Pesticides Act provide an appropriate level of accommodation for persons with particular sensitivities. However, the service provider could consider additional accommodation such as through a registry system whereby persons are personally notified of the intent to use adulticides.

Conclusions:

The City Council approved 2003 West Nile Virus Program was based on an integrated pest management (IPM) approach to mosquito control that includes 3 Tiers of intervention. It is possible that the Tier 1 (public education, source reduction and surveillance) and Tier 2 (larviciding in city-owned catch basins) measures outlined in the 2003 WNV program will not be sufficient to control disease in humans in Toronto. It will therefore be necessary to consider enhanced Tier 1 and Tier 2 mosquito control activities that include: strengthened education; increased standing water investigations; additional larvicide application in City-owned catch basins; expansion of the larviciding program to surface bodies of water and catch basins on private property; and the declaration of an emergency to mobilize resources to address WNV.

However, should analysis of all available surveillance data indicate that, in spite of all public education, source reduction and larviciding efforts made, the risk of WNV to humans remains high, the Medical Officer of Health will consider the use of Tier 3 measures (control of adult mosquitoes or adulticiding). Adult mosquito control would be focused in areas and at times where it is most likely to be effective in reducing the risk of human disease. It would be limited to geographic areas where surveillance shows a high number of adult mosquitoes, presence of WNV in the environment, a high likelihood of transmission of WNV to humans and when adult control is still potentially effective in controlling disease. Any adult mosquito control program will comply with relevant federal and provincial regulations. Toronto Public Health will take all the necessary precautions to minimize any potential adverse health and environmental effects associated with adult mosquito control.

The budget for the 2003 WNV program, approved by City Council, provided for a basic level of mosquito surveillance and control activities including the control of mosquito larvae in city-owned catch basins on the road allowance. Subsequent to Council approval of the program, Ontario Regulation 199/03 under the Health Protection and Promotion Act, came into effect. The regulation outlines the requirements for West Nile virus prevention and control in Ontario and requires the Medical Officer of Health to undertake a risk assessment based on all available data to determine what, if any, action is required to reduce the human risk from WNV. It is possible that this risk assessment will determine that further action is required.

To ensure that WNV program is effective and minimizes pesticide use, it is essential that TPH has the capacity to enhance the education and surveillance components. As well more extensive larval mosquito control may help avoid the use of adulticides, which carries potential health and environmental risks. The enhanced mosquito surveillance and control activities described in this report were not part of the base plan and will require additional resources. These resource requirements are outlined in a parallel report to the Board of Health "Update Report and Budget Implications for Enhanced Mosquito Control Activities for the 2003 West Nile virus (WNV) Program."

Contact:

Ronald Macfarlane
Supervisor, Environmental Health Assessment and Policy
Toronto Public Health
Tel: 416-338-8097
Fax: 416-392-7418
Email: rmacfar3@toronto.ca

Dr. Karl Kabasele
Associate Medical Officer of Health and Physician Specialist, Healthy Environments
Toronto Public Health
Tel: 416-338-8041
Fax: 416-392-1482
Email: kkabase@toronto.ca

Dr. Sheela V. Basrur
Medical Officer of Health

Attachments:

Attachment A Ontario Regulation 199/03: Control of West Nile virus
Attachment B Considerations of Toxicology, Ecotoxicity and Public Health in ULV Applications of Malathion for Mosquito Control
Attachment C West Nile Virus Summary Information (Ministry of Health & Long-Term Care)

Attachment A

Health Protection and Promotion Act
Loi sur la protection et la promotion de la santé
ONTARIO REGULATION 199/03

CONTROL OF WEST NILE VIRUS

This Regulation is made in English only.

Determination if action required

1. A medical officer of health shall make a determination, based upon a local risk assessment in accordance with the document published by the Ministry of Health and Long-Term Care entitled *West Nile Virus Preparedness and Prevention Plan for Ontario* , whether action is required by a municipality to decrease the risk of West Nile Virus to persons either inside or outside the health unit served by the medical officer of health. O. Reg. 199/03, s. 1.

Notice to municipality

2. (1) Where the medical officer of health has determined that action is required, he or she may give notice to the municipality of the required action. O. Reg. 199/03, s. 2 (1).

(2) In determining required actions under subsection (1), the medical officer of health shall have regard to,

(a) the document mentioned in section 1; and

(b) the generally accepted practices in the field of public health with regard to decreasing the risk of West Nile virus to persons. O. Reg. 199/03, s. 2 (2).

Must comply

3. A municipality shall comply with any requirements set out in the notice. O. Reg. 199/03, s. 3.

What may be required

4. Action required under this Regulation may include, without being limited to,

(a) requirements respecting source reduction measures;

(b) requirements respecting surveillance;

(c) requirements respecting public awareness campaigns about personal protection;

(d) requirements respecting the control measures for larviciding and adulticiding set out in Table 1; and

(e) requirements respecting the time within which the action shall be taken. O. Reg. 199/03, s. 4.

TABLE 1

LARVICIDING AND ADULTICIDING IN ONTARIO

WEST NILE VIRUS RESPONSE

"Triggers" based on surveillance of WNv positive humans, birds, mosquito pools or mammals (horses)

Current-Year WNv findings in Health Unit or municipality	Last Year's WNv findings in Health Unit or municipality	Preparatory Status (Larval surveys, mosquito trapping, mapping, training, etc.)	Larviciding ACTION	Adulticiding ACTION
No West Nile virus found yet	No West Nile virus found; virus found in adjacent Health Unit(s)	Not yet done	Do the preparatory work, then larvicide where indicated	Not indicated
No virus found yet	Virus found	Not yet done	Do the preparatory work, then larvicide where indicated	Not indicated
No virus found yet	Virus found	Done last year and under way this year	Larvicide where indicated	Not indicated
Virus found in non – human (dead bird, mosquito pool or mammal) - isolated or as a "hot spot"	Virus found or not found	Done or under way this year	If a "hot spot" and larvae are present, larvicide around this "hot spot" (if not too late in the season)	Adulticide a 3-km "Zone" ONLY IF there are high-risk indicators of transmission to humans*
Human case(s) - one or a few in a space-time "cluster"	Virus found or not found	Done or under way this year	Larvicide around the case or cluster if larvae are present (and if not too late in season)	Adulticide a 3-km radius Zone around the case or cluster
Human cases continue to occur; continued high-risk indicators*	Virus found or not found	Done or under way this year	Larvicide widely where larvae are found (if not too late in season)	Adulticide 3-km Zones - may be contiguous or overlapping

Note : Public education efforts and non-pesticide means of mosquito source reduction should be in place, and increased as increasing evidence of virus is found (especially human cases) in the current year.

* High-risk indicators of transmission to humans : increasing dead bird sightings; high mosquito infection rates; abundant bridge vector populations; increasing mammal (horse) cases; proximity of mosquito breeding sites to human populations (especially large population centres) and weather conditions that favour mosquito breeding.

1. These are minimum activity standards. Medical Officers of Health may increase the Zone size to be treated or take additional mosquito control actions, if justified by scientific data or recommendations.

2. Medical Officer of Health will maintain a means to record, investigate, and report any confirmed or likely adverse or unintended human health effects attributed to mosquito control actions, and will report any non-human environmental adverse effects that he or she knows about to the Ministry of the Environment and/or other relevant local or provincial authorities.

Attachment B

Considerations of Toxicology, Ecotoxicity and Public Health in ULV Applications of Malathion for Mosquito Control

Introduction

Malathion, which has been available for use in Canada since 1953, is a registered synthetic insecticide with a variety of commercial, domestic and public health uses. Health Canada's Pest Management Regulatory Agency (PMRA) recently completed a review of the use of malathion for adult mosquito control, stating that among the mosquito control products available for use in Canada, malathion has the most "current and comprehensive safety information available" (PMRA, 2003).(1) Malathion has a more up-to-date toxicological database compared to other types of pesticides that kill adult mosquitoes (such as several of the pyrethroid class of insecticides) but which are not registered in Canada and classified for use in Ontario for community-wide control.(2)

The malathion formulation and method used in public health applications is described as ultra-low volume (ULV). ULV is described as, "the application of the minimum effective volume of an undiluted formulation of insecticide in liquid form as received from the manufacturer" (Mount, 1998: 305). ULV ground aerosol applications have been the standard method of controlling adult mosquitoes world-wide for over 30 years because of greater safety and lower cost compared to high volume applications (Mount, 1998). ULV cold-fogging which is recommended by Health Canada does not use a solvent but involves less insecticide in an undiluted form (Health Canada, 2001a). It can be applied aerially using an aircraft, or on the ground using truck-mounted aerosol sprayers or by applicators equipped with backpack sprayers. In public health applications a trained, professional applicator or pest control operator is involved.

Application rates in ULV uses are 60.8 grams/hectare for ground and 260 gms/ha for aerial applications (PMRA, 2003). (3) The typical droplet diameter from ground-based ULV applications is very tiny, between 8 and 30 microns or about 0.008 to 0.03 millimeters (Rose, 2001).

Health Effects of Malathion

Malathion is an organophosphate (OP) insecticide of moderate acute toxicity, which is comparatively lower than the toxicity of other OP insecticides (such as chlorpyrifos (4) or diazinon). Insecticides of the OP class are neurotoxic because they are cholinesterase inhibitors. With acute exposures to high doses they inactivate the enzyme acetyl cholinesterase, which normally breaks down acetylcholine, a neurotransmitter. When cholinesterase is inactivated, acetylcholine accumulates causing overstimulation of nerve endings and malfunction of the nervous system and other body systems. Though the PMRA and the U.S. EPA suggest that overexposure to malathion from ULV mosquito control applications is unlikely, symptoms of acute exposure include nausea, dizziness, confusion, headaches, weakness, diarrhea, eye, skin, nose or throat irritation or breathing problems (PMRA, 2003; U.S. EPA, 2000b).

Malathion can be absorbed via inhalation, oral or dermal routes. It does not accumulate in body organs or tissues but is metabolized in the liver and excreted mainly in urine, feces and expired air. Rate of excretion of malathion is species-specific with a half-life of about 8 hours in rats and 2 days in cows (Kamrin, 1997). There is some evidence that malathion crosses the placenta in test animals and can be excreted in relatively smaller amounts through milk (ATSDR, 2001). Small amounts (5 ppb) of malathion were detected in breast milk from 1 of 11 Italian women from the general population 5 days postpartum, but was not detected by 11 days (Roggi, et al, 1991). However, other researchers were unable to detect (5) malathion in the milk of nursing women in California where it had been aerially applied for Medfly control (Lonnerdal & Asquith, 1982).

Dermal absorption of malathion is estimated at 10% (ATSDR, 2001). Some individuals find malathion irritating to skin, eyes, mucous membranes and lungs (ATSDR, 2001). Malathion is a weak contact sensitizer, inducing a mild skin reaction in a high proportion of subjects experimentally exposed (HSDB, 1999). Some people appear to report mild symptoms from smelling malathion which has a strong odour. Malathion was among several pesticides suspected of contributing to wheezing symptoms in a study of over 20,000 farm pesticide applicators and has been associated with increased incidence of respiratory infections in workers involved in manufacture of OP pesticides and presumably with relatively greater potential for exposure to malathion (Hoppin et al, 2002; ATSDR, 2001).

As an OP pesticide, the target organ for effects is the nervous system. At high doses malathion affects nerve transmission because of cholinesterase depression. Many of the systemic and nervous system effects are caused by malaoxon an active metabolite of malathion (ATSDR, 2001).

Based mainly on some animal studies showing increased production of liver tumours (in mice and female rats) at high exposure doses, the U.S. EPA states the evidence is “suggestive of carcinogenicity” in animals from malathion but that data are inadequate to assess human carcinogenic potential (U.S. EPA 200c). It should be noted that there has been considerable deliberation regarding the carcinogenicity status of malathion. While the majority of scientists reviewing evidence on behalf of the U.S. EPA support the “suggestive” categorization, smaller numbers supported a “not likely carcinogenic to humans” position, whereas a minority supported a status of “likely to be carcinogenic to humans” (CARC, 2000; FIFRA-SAP, 2000; Dementi, 2000). A number of epidemiological studies indicate a positive though weak association between exposure (largely occupational) to malathion and certain cancers such as non-Hodgkin’s lymphoma and leukemia (ATSDR, 2001).

Some animal studies suggest malathion is linked to changes in immune system function with both immune enhancing and immune suppressive effects having been observed (Bannerjee, 1999; Vial et al, 1996; Voccia et al, 1999; Johnson et al, 2002). It is unclear what the mechanisms of action are for immunologic changes from malathion exposure (ATSDR, 2001). The significance in terms of human immune function or disease susceptibility of observed immune parameter changes from chronic exposure to malathion in test animals is also unclear and there is limited information on immune changes in humans exposed to malathion (ATSDR, 2001). *O,O,S*,-trimethyl phosphorothioate (OOS-TMP), an impurity that can appear at low levels (6) in technical grade malathion, has been found to reversibly inhibit the immune system in mice at different doses (Vial et al, 1996). Other studies, however have shown either enhancement or suppression of immune responses associated with OOS-TMP exposure in mice depending on dose (Voccia et al, 1999).

Though pesticides were not detected in the tissues of affected lobsters, U.S. researchers are examining whether exposure to malathion (or several other pesticides used in WNV-related mosquito control) could have affected the immune system functioning of Long Island Sound lobsters leading to greater susceptibility to mortality from a paramoeba infection (Sea Grant LIS Lobster Initiative, 2001). Experimental research conducted thus far suggests that short-term exposure to relatively low concentrations of malathion leads to reduction in immune system functioning that could have resulted in an increased susceptibility to infectious agents in lobsters (De Guise et al, 2003).

Animal data suggest that developmental effects occur only at maternally toxic (that is, relatively high) oral doses of malathion. Experimental studies indicate malathion can cross the placenta and be transferred through milk (ATSDR, 2001). Recent developmental neurotoxicity studies in animals suggest that while fetuses may not exhibit greater cholinesterase inhibition from malathion than their pregnant mothers, there does appear to be increased sensitivity to direct postnatal exposure to malathion in immature versus adult animals (U.S. EPA, 2002). Young animals may be more sensitive because of less effective detoxification enzyme systems (U.S. EPA, 2002).

Malathion appears not to disrupt functioning of reproductive hormones (Sonnenschein & Soto, 1998; Chen, et al, 2002). However, although observed effects have not been consistent, malathion may disrupt thyroid function at low doses according to studies in rats and aquatic species such as bullfrog tadpoles and some fish (see for example, Akhtar, et al, 1996; Fordham et al, 2001; Sinha et al, 1992; Yadav & Singh, 1987). One third of a sample of patients with OP poisoning who had intentionally ingested unknown, but likely high amounts of malathion displayed temporary lowering of thyroid hormone levels (ATSDR, 2001).

Exposure and Effects from Public Health Applications

The U.S. EPA estimates that the amount of malathion to which either adults or toddlers would be exposed in the mosquito control scenario (ULV application) is very small, hundreds or even thousands of times below an amount that could pose a risk of concern to people. The margins of exposure (MOEs) for combined dermal and inhalation exposure from ground ULV applications for mosquito control are 22,000 for adults and 7,700 for toddlers, significantly greater than 100, the benchmark value for MOEs defined as adequately health protective (U.S. EPA, 2000c). (A higher MOE means a greater safety margin and lower risk from exposure.) Nonetheless, various agencies recommend the public take appropriate precautions to minimize exposure where mosquito control spraying occurs (See for example, ATSDR, 200; NYS DOH, 2002).

Where spraying for mosquito control occurs, the public may be exposed if they are outdoors during actual spraying, or if they touch contaminated plants, soil, turf or other outdoor surfaces, or eat unwashed contaminated garden produce within a day or so after spraying. For example, though there are no reports examining biological measures of exposure, 37 people in the town of Moreau, New York who were attending a softball game were reportedly made ill from an unannounced ULV malathion spraying that occurred during the game in an adjacent forest (Tracy, 2001).(7) For example, one case report indicated a man developed a rash on areas of his skin that had contact with a pool cover he had removed after spraying of malathion for mosquito control (U.S. CDC, 1998). Children potentially have relatively greater exposure because they are smaller, closer to the ground and more often put objects and their hands, into their mouths (ATSDR, 2001).

Experimental studies show that in ground applications, surface malathion deposition amounts decreased exponentially with increasing distance from the spray truck (or the street) and detections also decreased with time since application (Knepper et al, 1996; Tietze et al, 1996; Moore et al, 1993).

Because exposure to any pesticide may potentially result in adverse reactions, especially in those with sensitivity to pesticides or with pre-existing respiratory conditions, should adulticiding be undertaken, the public must be thoroughly informed about spraying schedules and about ways to avoid exposure. Since there is greater potential for exposure to pesticides used in adulticiding (versus larviciding) activities, public health officials must also advise health care providers regarding the symptoms of possible overexposure to malathion. It would be advisable to also plan for systems of surveillance for adverse health effects following such broadcast pesticide applications, whether by physician reporting or monitoring of calls to poison control centres (NYC DOHMH, 2003). Though New York City has used the pyrethroid sumithrin for mosquito adulticiding in recent years, they found no cases of individuals reporting to emergency departments or seeking care from their physicians for health complaints related to adulticide exposure through their monitoring or data review activities since 2000 (NYC DOHMH, 2003).

There are few population-based reports in the published medical literature of exposure or of acute or chronic health effects related to public health applications of malathion specifically regarding its use against WNV. There are some analyses from U.S. jurisdictions, however, most of these have not used malathion exclusively, many relying on some of the synthetic pyrethroids, the formulations for which are not available in Canada or classified in Ontario for public health applications.(8)

In an experimental study, Moore and colleagues (1993) observed that deposition of malathion on the surfaces of adult volunteers at various positions downwind from a truck sprayer was well below 2 micrograms/cm^2 (highest deposition was on arms and upper torso, on those who jogged for an unspecified time 1.5 metres downwind of the spray truck). They concluded that, at an estimated average exposure dose of 0.7 mg, the adult volunteers may have absorbed an amount of pesticide that was four orders of magnitude or more below the acute lethal dose for rabbits (LD_{50} = 4100 mg/kg) (Moore et al, 1993). Researchers from the U.S. Centers for Disease

Control and Prevention (U.S. CDC) concluded that there was no increase in exposure levels to permethrin from ULV applications in 2002. They were unable to show differences in pesticide metabolites in urine samples of residents from four cities in Mississippi, two of which had employed truck foggers for adult mosquito control and two others which were not exposed to permethrin for mosquito control (Luber, 2003, pers. comm.).

The Florida Department of Health assessed the potential adverse health effects related to the ULV ground and aerial spraying of malathion in a corn protein bait to control the Mediterranean fruit fly (Medfly) outbreak in 1998. Of the 230 total reports of pesticide-related illness (based on symptoms consistent with malathion or bait toxicity) received after the spraying, 15% were classified as probable and 39% as possible. There were no reports classified as definite because clinical or environmental samples were not available for laboratory confirmation (U.S. CDC, 1998). The tally of probable and possible cases represented a crude rate of nine reported cases per 10,000 population (or about 900 per million) exposed (U.S. CDC, 1998). Studies of a sample of 119 volunteers from Texas indicated a 5% incidence of mild, transient, non-specific symptoms such as headache, nausea and weakness after aerial malathion spraying against St. Louis Encephalitis but these were not associated with cholinesterase inhibition (Gardner & Iverson, 1968).

The California Department of Health took extensive steps to evaluate health effects related to the use of malathion in a corn syrup bait for Medfly eradication in 1989. Researchers there were unable to detect any increase in hospital visits for respiratory conditions following aerial application of malathion, however, the sample size may have been too small to allow adequate detection of effects (Kahn et al, 1992). The Los Angeles County Toxics Epidemiology Program received 1,874 reports from residents who believed they had suffered illness due to spraying during that period (as cited by Schanker et al, 1992). Among these complaints, most involved symptoms of upper and lower respiratory tract irritation, headaches, gastrointestinal tract, malaise and skin rashes. Many of these reports were however, unconfirmed and in addition, because there was no clear correlation between degree of exposure and the occurrence of symptoms, causal interpretation was difficult (as cited by Schanker et al, 1992).

In two studies of allergic reactions among the subset of individuals in Los Angeles county reporting skin rashes, researchers were unable to show reactions to malathion with skin patch testing in any subjects. Only a small proportion showed a positive reaction to the bait (a plant-derived protein) (Schanker et al, 1992)(9).

Though studies by California Department of Health researchers lacked statistical sensitivity, they were unable to show an increase in use of health care facilities or in emergency treatment for asthma after a 1981 aerial malathion spraying for Medfly (Kahn et al, 1992). The authors state that, "this finding accords with the subjective impression of the medical community, i.e. there was no increase in illness compatible with organophosphate exposure – or any other illness – after the spraying" (Kahn et al, 1992: 283).

Researchers were unable to show any significant associations between malathion exposure and most types of adverse pregnancy outcome in a case-control study of southern California women who were pregnant during a period of Medfly malathion spraying in the early 1980s (Grether et al, 1987; Thomas et al, 1992). Positive associations were found between exposure and some anomalies, but not in a biologically consistent pattern and there was no significant relation between low birth weight occurrences and malathion exposure (Grether et al, 1987). There was an elevated risk of non-specific gastrointestinal anomalies (based on 13 cases) related to 2nd trimester exposure in this study however, the relationship to malathion exposure is unclear given that the human gastrointestinal tract is fully formed before the 2nd trimester (Thomas et al, 1992; ATSDR, 2001).

Most malathion incident data (that is, “poisoning” reports) refer to acute exposures and usually involve mild, temporary symptoms which appear to be a reaction to the offensive odour rather than being linked to cholinesterase depression (U.S. EPA, 2000c). Some suggest that anxiety related to spraying may also account for some portion of reported symptoms (Kahn et al, 1990; Kahn et al, 1992). Researchers from the California Department of Health Services found there was a non-significant decrease in self-reported anxiety-related symptoms after aerial spraying activities in a small, random interview sample of residents (Kahn et al, 1992).

Although there appear to be negligible acute risks to health from ULV applications of malathion for most people (if spraying directions and exposure avoidance measures are followed), some individuals may display greater sensitivity to the irritant or allergic effects of malathion (U.S. CDC, 1998). While all individuals should be advised to take appropriate precautions to avoid exposure, because people with asthma, respiratory or allergic conditions may be more sensitive to malathion they should take all possible precautions to avoid exposure (ATSDR, 2001; NYS DOH, 2002).

The Chief Ontario Human Rights Commissioner has recently advised municipalities that they must consider the effects of the use of chemical agents in controlling mosquitoes (OHRC, 2003). Specifically, the Commission’s “Policy and Guidelines on Disability and the Duty to Accommodate” considers “environmental sensitivity” (or multiple chemical sensitivity) as a disability and thus protected under the Code. The Chief Commissioner notes that environmental sensitivity is “triggered by the exposure to common environmental chemicals in lower levels than those that tend to affect the general public”. (OHRC, 2003). As such, he advises that municipalities will have to provide a mechanism to protect such individuals when implementing their mosquito control programs. Local Medical Officers of Health have requested the MOHLTC to advise on what public health units must do to address this issue.

Ecological Effects of Malathion

There has been extensive research examining the effects of malathion on non-target organisms. Malathion has relatively low toxicity for birds, mammals and reptiles, although there is concern for chronic effects in birds from repeated or high exposure or of sublethal effects in small mammals with high application rates (that is typically higher than those used for mosquito control) (ATSDR, 2001; U.S. EPA, 2000b). Malathion is very toxic to beneficial insects such as bees that may be exposed directly or to residues present on vegetation (Kidd & James, 1991; Hester et al, 2001). Temporary population reductions have been observed in some flying insect populations from ULV applications (Jensen et al, 1999). It is also highly toxic (both acutely and chronically) to aquatic organisms (fish and aquatic invertebrates) at relatively low concentrations (U.S. EPA, 2000b).

Field studies and monitoring data show substantial adverse effects on sensitive non-target aquatic organisms especially aquatic invertebrates, aquatic-stage amphibians and certain species of fish at prevailing application rates for effective mosquito control (Milam et al, 2000; U.S. EPA, 2000d). There have been many reports of ecological effects (e.g. substantial fish, invertebrate and frog mortality) related to urban malathion spraying (U.S. EPA, 2000d).

For these reasons it is advisable to conduct adulticiding (should it be deemed necessary) such that it occurs at times when bees are not active and avoids exposure to natural bodies of water. It is also advisable to implement programs to monitor for pesticide residues and their metabolites in local waterways and to assess environmental impact after public health applications.

There is some evidence that in geographic regions where malathion public health spraying for mosquito control is widespread and frequent and has occurred over several years (about ten years), the target mosquito species have developed resistance to the effects of malathion (see for example, Karunaratne & Hemingway, 2001; Coto et al, 2000; Eritja & Chevillon, 1999; Bisset et al, 1991).

Environmental Fate of Malathion

While most of the malathion released remains close to areas of application, there is the possibility that some is transported away by rain runoff, fog, and wind. With ULV applications, effective adult mosquito control is dependent on a certain amount of spray drift (Rose, 2001). Spray drift is expected to be higher with aerial versus ground applications (35% vs. 5% respectively) (U.S. EPA 2000d).

Within a few days to several months, malathion breaks down in soil and water to other chemical compounds with exposure to bacteria, water or moisture and sunlight, (ATSDR, 2001). The half-life of malathion in soil is 1 to 2.5 days (U.S. EPA, 2000e). Soil degradation of malathion is affected by moisture, organic content and pH with degradation being most rapid in moist, aerobic conditions with high organic content (that is, microbial organisms) and higher (or alkaline) pH (U.S. EPA, 2000e). Malathion dissipates in soil by leaching, plant uptake and surface runoff but does not volatilize appreciably (U.S. EPA, 2000e). Although malathion is fairly mobile in soil, because it breaks down relatively rapidly, it is unlikely to reach groundwater in significant amounts (U.S. EPA, 2000c).

The half-life of malathion in water varies with water salinity but is typically 1 day to several weeks (Kamrin, 1997). While malathion was among the four insecticides most commonly detected in a study of U.S. urban streams (Hoffman et al, 2000), it has not been detected in studies of urban surface waters in Southern Ontario conducted by Environment Canada (Struger et al, 2002).

Malathion is not generally considered to be bioaccumulative or persistent. However, samples of brown shrimp have shown malathion concentrations approximately three orders of magnitude greater than the surrounding water concentrations (Howard, 1991).

Efficacy of Adulticiding with Malathion

Reviews of both ground and aerial ULV applications conclude that they are as effective as high or low volume aerosol applications and safer for controlling mosquitoes (Mount et al, 1996; Mount, 1998). A number of factors related to application conditions will influence the efficacy of ULV adulticiding activities including droplet size, flow rate, time of application and favourability of meteorological conditions (Mount, 1998).

The efficacy of the ULV aerosols is linked to the tiny droplet size used with 8 to 15 microns being the optimum volume median diameter for droplets as determined by lab and field tests for ground applications (Mount 1998). Ground ULV applicators typically produce no droplets above 50 microns diameter which is desired as concentrated droplets of malathion greater than 50 to 100 microns can damage automotive or other paint finishes (Rose, 2001).

With ULV applications, effective mosquito control is achieved by ensuring that the insecticide aerosol drifts across areas where mosquitoes are flying and that the droplets impinge on the mosquitoes themselves (Rose, 2001). Data indicate that aerosol ground spraying is likely to be most effective therefore, when there is a horizontal wind of between 1.5 to 11 kilometers (1 to 7 mph) to carry the aerosol cloud into the target area (Mount, 1998).

Aerial spraying is more effective than ground-based applications because it results in more even distribution of the pesticide. For ground applications, the density of vegetation and structures (that is, buildings or houses) that impede aerosol drift across target areas may affect mosquito control efficacy (Mount, 1998). Efficacy is also dependent on the time spraying occurs – which is usually two hours around dusk or dawn when mosquitoes are at their peak flying activity. Different species of mosquitoes have varying susceptibility to different pesticides. Before a product is registered for a certain use the manufacturer must provide efficacy data. Experimental and field studies assessing effects from ULV applications of malathion typically indicate better than 90% mortality of mosquitoes (Culex sp.) with application rates that are within the label recommendations (Mount, 1998).

Health Canada notes that “because of logistical difficulties, few studies have been performed that clearly demonstrate that the application of adulticides decreases the incidence of human infection with mosquito-borne pathogens, though many have shown that spraying of adulticides kills adult mosquitoes” (Health Canada, 2001b). While adulticides such as malathion can reduce mosquito populations by over 90% at recommended application rates, mosquito populations recover quickly. In general, the abundance of adult mosquito populations is reduced following treatment but typically mosquito populations are suppressed for only 7 to 10 days. As a result, adulticides may have to be reapplied, in order to reduce mosquito abundance below the threshold at which virus transmission to humans occurs. For example, the U.S. CDC (2001) recommends that about

2 to 3 applications from 3 to 4 days apart may be required to ensure complete control of *Culex* species of mosquito.

At a recent WNV conference held by the U.S. CDC, the meeting summary notes that important questions surround whether sustained mosquito control activities (against both larval and adult stages) are effective in preventing or reducing human illness despite what are described as “dramatic decrease in densities of important vectors” (U.S. CDC, 2003).

Only a few studies have tried to assess the effectiveness of mosquito control programs on the disease transmission. Studies of the incidence of St. Louis Encephalitis (SLE), another arbovirus, are largely inconclusive concerning the efficacy of ULV adulticiding which has not been limited to the use of malathion. Mosquito control measures employed against the vector species involved in SLE have not proven entirely effective in reducing the total disease burden in humans but they do kill vector mosquitoes (Hopkins et al, 1975). However, one study in Texas did report that the incidence of SLE cases dropped to almost zero within two weeks (shorter than the period of decline naturally associated with the epidemic curve for SLE) after aerial malathion spraying (Gardner & Iverson, 1968).

Questions have been raised about the value of applying adulticides after human deaths or infection from WNV in humans have already been confirmed given the substantial time lag between transmission, onset of symptoms and diagnosis. It takes one month or more between infection, onset of symptoms and confirmation of WNV diagnosis. Mosquito populations peak in late July early August. Mosquito control that is instituted in late August or in September, when human cases are initially apparent, will miss the period where the risk of transmission is greatest and is likely to prevent only a minority of cases in that year. Similarly, it was observed that emergency mosquito control programs instituted after SLE epidemics started did not reduce the number of human cases (Powell & Kappus, 1978).

A further consideration in discussing efficacy of any chemical mosquito control is the question of pest resistance. Regular use of any pesticide can lead to the development of resistance in the target pest. Resistance to malathion has been found in certain mosquito species in different regions of the world, including the U.S. The main approach to manage resistance is to minimise the use of pesticides through Integrated Pest Management and to alternate between types of pesticide used. The U.S. Department of Health and Human Services discusses approaches to managing mosquito resistance from adulticiding (U.S. CDC, 2001).

Considering these limitations, the choice to apply adulticides should be seen as a last resort to prevent human infections and all other preventive measures (such as, personal protective and avoidance strategies, and so on) should be recommended before or simultaneously with any adulticiding program (Health Canada, 2001b).

Other Considerations

Effective mosquito control efforts are also reliant on factors other than application conditions, including public education. For example, a randomised community trial by researchers from the University of Colima in Mexico evaluated the efficacy of different methods for reducing *Aedes* *aegyptii* breeding sites (against dengue fever). Interventions included an intense, door-to-door education campaign alone, ULV adulticiding using malathion, education plus adulticiding and no intervention among controls. The study indicated that reduction in mosquito counts was more effective around homes that had received educational material alone in comparison to homes where there was only malathion spraying or where there was both education and spraying. (It should be noted that educational content included instructions on using biological and chemical control methods for mosquito larvae around the home as well.) The researchers suggest that the negative effects of having both education and spraying are possibly because of a false expectation of protection from spraying (Espinosa-Gomes et al, 2002). Public education campaigns regarding exposure avoidance were also found to be effective in protecting against contracting SLE (Meehan et al, 2000).

Research assessing public knowledge of personal protective measures is indicative of where education efforts should be directed. For example, focus group research conducted by the U.S. CDC in Louisiana in the summer and fall of 2002 found that while people know they should use a mosquito repellent, most reported not having used it with regularity when they were outdoors (Zielinski-Gutierrez, 2003). The main reasons for not using repellant were not remembering and the inconvenience of the products (Zielinski-Gutierrez, 2003). Researchers conclude that future WNV prevention activities require greater targeting of information to those at greatest risk (such as persons over age 50). They also suggest personal delivery of information concerning multi-level actions (e.g. repellent use, avoidance, source reduction, mosquito control, etc.), from local, community sources so as to adequately influence behaviour change (Zielinski-Gutierrez, 2003).

While we do not have current data for Toronto on public knowledge concerning WNV transmission and prevention, Rapid Risk Factor Surveillance System (RRFSS) surveys of 401 residents in Durham Region conducted in September 2001 are somewhat illustrative of where local public education must be enhanced.(10) The Durham RRFSS survey indicated that high proportions, better than 80% (+/- 4%), reported that they did not allow water to collect in areas or objects around their home, and that that they kept window and door screens in good repair (ISR, 2003). However a much lower proportion of respondents reported taking personal protective measures such as staying away from outdoor areas where mosquitoes were likely to bite (38%), limiting outdoor activities at times of greatest mosquito biting (31%) or wearing protective clothing or using insect repellant during outdoor activities (37%) (ISR, 2003). A 2002 survey conducted by the Harvard School of Public Health reported similar figures for proportions of Americans who were taking personal steps to avoid mosquito bites (HSPH, 2003).

Finally, any municipality considering the use of broadcast applications of malathion for adult mosquito control cannot underestimate the public's apprehension about this activity. A recent U.S. survey indicated that 77% of Americans would favour special spraying to prevent the spread of WNV (HSPH, 2003). However the perceived risks of spraying(11) held by some people undoubtedly will be a considerable challenge to counteract locally. For example, among the opponents to malathion spraying that have appeared of late is the *Canadian Coalition for Health and Environment*, a non-governmental, Ottawa-based group which lists respected physicians and scientists in North America among its supporters (CCHE, 2003). This group characterizes malathion spraying as ultimately increasing the chances of people dying from WNV, assuming that depressed immune system effects result inevitably from malathion exposure and that the immunosuppressed are at greatest risk from WNV.(12) Clearly this interpretation will be a challenge to counterbalance given the public's perception that health professionals and physicians in particular are a credible source for information about WNV and the impact of adult mosquito control activities.

In California in the 1990s, public health officials found that dealing with public anxiety surrounding the malathion spraying campaign against Medfly was an important public health issue on its own (Kahn et al, 1990). Researchers reported that the most important means of counteracting the heightened public concern was to form a Health Advisory Committee composed of "recognized experts and local professionals and leaders to provide an authoritative, respected and sympathetic voice to deal with the community's concerns" (Kahn et al, 1990: 1301). Kahn and colleagues (1990) also recognized the importance of other actions such as, working closely with the media to ensure accurate reporting of information on the spraying campaign, an independent assessment of health risks from ULV malathion by the Health Advisory Committee and the promise of surveillance and monitoring activities to address public concerns about pesticide exposure.

Since last summer, Toronto Public Health staff has already received correspondence and calls from residents expressing marked concerns and apprehension about the possibility of any chemical mosquito control methods being employed here.

Conclusions

The recent reviews by the PMRA and the U.S. EPA conclude that there is no unacceptable risk to the public from the use of malathion in ULV applications to control adult mosquitoes. They estimate that the amount of malathion to which either adults or toddlers would be exposed in the mosquito control scenario (ULV application) is very small, hundreds or even thousands of times below an amount that could pose a risk of concern to people. The risks to the general population from these applications are seemingly small, largely because the volume of pesticide applied is very low, malathion degrades after one to two days and therefore the exposure is likely to be minimal particularly if all appropriate precautions and exposure avoidance measures are observed. There are however, documented concerns regarding malathion exposure to aquatic species and to beneficial insects such as bees.

Many factors must guide the decision to implement enhanced mosquito control measures. Though ULV treatments appear to temporarily reduce mosquito populations there is little solid information on the long-term efficacy of such measures for reducing the burden of illness from WNV. There are also questions concerning the value of applying adulticides after human deaths or infection from WNV in humans have already been confirmed. Clearly, the potential benefits of such emergency measures must be weighed against the potential health risks for those with environmental sensitivities and from the public anxiety that is certain to manifest surrounding these activities.

Prepared by: Loren Vanderlinden, Health Promotion & Environmental Protection Office, Toronto Public Health, June 2003.

Footers

(1) The Health Canada document, *Municipal Mosquito Control Guidelines* (2001a) states that among several factors to consider in the choice of an adulticide it is "recommended that only products with a history of use in Canada and recent human health and environmental risk assessments, conducted by the US Environmental Protection Agency or the PMRA of Health Canada, be used". While both malathion and chlorpyrifos fit these criteria, malathion is the only product currently registered by PMRA which can be applied in ULV format using either aerial or ground equipment, chlorpyrifos only being registered for ground fogging (non-ULV) applications (Health Canada, 2001a).

(2) Note that while there is one synthetic pyrethroid resmethrin that is classified for use in Ontario as a mosquito adulticide, its registered formulation does not include the synergist, piperonyl butoxide (PBO) which enhances the insecticidal activity. As a result, the resmethrin available for ULV is described as having poor efficacy (Cutten, 2002). Other pesticides classified for use in Ontario for community-wide adulticiding activities include chlorpyrifos (see footnote 4) and propoxur.

(3) Note: 200 gms or mL/ha = ~ 3 fl oz/acre, that is, at least 5 to at most 55 times lower than the volumes applied in agriculture and approximately 7 to 77 times lower than the volumes applied in garden and turf uses (U.S. EPA, 2000a).

(4) Note that chlorpyrifos is another OP pesticide registered for use in Canada for mosquito control applications though not for ULV but for ground fogging or residual spraying which involves higher application rates (Health Canada, 2001a; Cutten, 2002).

(5) Method detection limit was 5 ppb.

(6) In 1991, the California Department of Food and Agriculture reported that technical malathion contains impurities at up to 5% and OOS-TMP was represented as 0.45% (as cited in U.S. EPA, 2000e).

(7) In 2002, the Town of Moreau decided as a result to end its adulticiding program and now distributes free Bti "donuts" to residents for larval mosquito control (Tracy, 2002; Town of Moreau, 2003).

(8) See footnotes 1 and 2 above.

(9) The researchers note that because of low participation rates specific conclusions could not be drawn from these studies.

(10) It must be acknowledged that in light of the greater impact of WNV in the summer of 2002, *after* the RRFSS study was conducted, these findings may not adequately depict the current state of knowledge on WNV prevention for people in the Greater Toronto area.

(11) For example, mosquito adulticiding has been described in one media report as tantamount to "chemical terrorism" (Grant, 2001).

(12) As noted above, while animal studies of immune alterations from malathion have shown both immune enhancement as well as suppression, little is known of the immune effects in humans exposed to ULV applications. As well, the meeting summary from the recent WNV conference held by the CDC suggests that we cannot confidently say that only the immunosuppressed are most at risk of serious illness from WNV (U.S. CDC, 2003). Toronto data reported elsewhere also indicate that contrary to initial expectations, serious WNV disease in 2002 was not confined solely to elderly people with pre-existing medical conditions since significant morbidity did occur among previously healthy young individuals (TPH, 2003).

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Attachment C

WNv Case Categories

This table provides a summary of the various categories of WNv cases identified by the interpretation of the primary laboratory-screening test, IgM ELISA. For additional information on other laboratory tests and specific clinical criteria, please refer to the Case Definition document included with this package.

	Category	Clinical Criteria	Laboratory Criteria
West Nile virus Neurological Manifestations	Suspect	Yes	Pending
	Possible	Yes	Serum IgM ELISA Indeterminate
	Probable	Yes	Serum IgM ELISA Positive
	Confirmed*	Yes	Serum IgM ELISA Positive + Confirmation by PRNT
West Nile virus Fever	Suspect	Yes	Pending
	Possible	Yes	Serum IgM ELISA Indeterminate
	Probable	Yes	Serum IgM ELISA Positive
	Confirmed*	Yes	Serum IgM ELISA Positive + Confirmation by PRNT
West Nile virus Asymptomatic Infections	Probable	No	Serum IgM ELISA Positive
	Confirmed*	No	Serum IgM ELISA Positive + Confirmation by PRNT

*** Note: After five cases have been Confirmed by PRNT in a health unit area, cases meeting the Probable laboratory criteria will be classified as Confirmed cases.**

(Excerpted from Ministry of Health & Long-Term Care document entitled "West Nile Virus Summary Information", mailed out to Ontario physicians, May 21, 2003)

Attachment D

Ontario Human Rights Commission
Chief Commissioner
180 Dundas Street West
Toronto ON M7A 2R9
Tel (416) 314-4541

COURIER Postal Code:
M5G 1Z8

Tel. (416) 314-4537
Facsimile: (416) 314-7752

Commission ontarienne des droits de la personne
Commissaire en chef
180 rue Dundas ouest
Toronto ON M7A 2R9
Tél (416) 314-4541

Code Postal pour livraison
M5G 1Z8

Tél. (416) 314-4537
Télécopie: (416) 314-7752

Ontario

April 16, 2003

Ms Pat Vanini
Executive Director
Association of Municipalities of Ontario
393 University Ave. Suite 1701
Toronto, ON
M5G 1E6

Dear Ms Vanini,

Pursuant to the Ontario Human Right Commission's (the "Commission's") mandate under section 29 of the Ontario *Human Rights Code* (the "*Code*") to inquire into incidents of and conditions leading to tension or conflict based on prohibited grounds of discrimination, I am writing with regard to the Ministry of Health and Long-Term Care's (the "Ministry's") "West Nile Virus Action Plan" announced on March 22, 2003.

As indicated in the Ministry's Backgrounder entitled "Eves government unveils 'made in Ontario' West Nile virus action plan," the Ministry plans to implement "mosquito control techniques" as part of a seven-step approach developed to attack the disease. These techniques include the use of larvicides and possibly adulticides as measures to control the mosquito population.

It is my understanding that the Ministry is leaving the decision on whether to use pesticides, including adulticides, up to municipalities. It is also my understanding that there are no province-wide guidelines in place to ensure that mosquito control plans are implemented consistently, or in accordance with any set protocol.

Halting the spread of the West Nile virus is an important objective, and one of consequence to all Ontarians. However, concerns have been expressed to me about the Ministry's proposed strategy of using chemical agents, particularly adulticides, as part of its strategy to deal with this problem. Apart from reservations that the general population may have about the unknown effects of using chemical sprays, also referred to as "fogging" agents, on areas inhabited by the public, the use of such agents is of particular concern to persons identified by *Code* grounds such as persons with disabilities, parents of young children, and pregnant women. In particular, the use of these chemicals would likely have an adverse impact on individuals with environmental sensitivity.

Environmental sensitivity (also referred to as multiple chemical sensitivities, cerebral allergies, chemical-induced immune dysfunction, etc.) is triggered by the exposure to common environmental chemicals in lower levels than those that tend to affect the general public.

The *Code* provides that every person has a right to equal treatment with respect to services without discrimination because of disability. It is the Commission's policy position, as outlined in its *Policy and Guidelines on Disability and the Duty to Accommodate*, that environmental sensitivity is a disability and is thus protected under the *Code*. As such, the Ministry, as well as any municipality responsible for implementing the use of chemical insecticides, has a duty to provide accommodation to persons with environmental sensitivity. Failure to do so may contravene the *Code*.

When considering the use of chemical agents as a mosquito control technique, I would ask municipalities to be aware of their human rights obligations and to consider the effect of their plans on persons protected by the *Code*. **As Executive Director of the Association of Municipalities of Ontario, it would be appreciated if you could convey this message to your members immediately.**

Please be advised that in keeping with the Commission's commitment to public accountability and its duties in serving the people of Ontario, this letter may be made public.

If you have any questions or wish to discuss this issue further, please do not hesitate to contact me or my office.

Yours truly,

Keith C. Norton, Q.C., B.A., LL.B.
Chief Commissioner