CHAPTER 4.C
PUBLIC HEALTH

A. INTRODUCTION
The primary purpose of the proposed Mosquito Population Control Program in the Rockaways is to minimize the detriment to quality of life for citizens in the Rockaways. One means of adult mosquito population control is adulticide spraying, which in itself may pose a risk to public health. The analysis in this chapter examines the anticipated benefits to public health from adult mosquito control versus the potential for a percentage of the Rockaway’s population to come into contact with an adulticide used for mosquito control and to react adversely to it following both short-term and long-term exposures.

This assessment utilized research and additional studies performed for the Mosquito-Borne Disease Control Program, which are described in Chapter 3.C, “Public Health.”

B. PROBABLE IMPACTS OF THE PROPOSED ACTION
To examine the potential for adverse public health impacts from the Proposed Action, this assessment utilized research and additional studies performed for the Mosquito-Borne Disease Control Program which are described in Section 3.C. The public health analysis employed three techniques: Literature Review, Risk Assessment, and Epidemiologic and Attributable Risk Analyses, as described below.

METHODS OF ANALYSIS

Literature Review
A literature review was conducted to assess potential human and animal effects of pesticide exposure based on peer-reviewed published articles as well as government documents. As described in Chapter 3.C, “Public Health,” the literature review included parameters to search all human epidemiological and case study data resulting from exposure to one or more of the insecticides, and toxicity studies in whole animals and isolated tissues under experimental conditions. From the full list of search results, only those documents relevant to single compound exposures at common daily or occupational levels were reviewed. The resulting body of literature discovered using these methods is as comprehensive and conclusive as possible for all important, scientific, peer-reviewed literature to date on the six active ingredients and their likely human health effects.

Risk Assessment
The objective of the risk assessment in this environmental impact statement (EIS) is to determine whether the application of adulticides to control an abundant mosquito population in the Rockaways may pose a significant human health risk. In a public health risk assessment, there are four steps, each of which is briefly described below:

- Hazard Identification identifies the chemicals of concern to be analyzed.
Exposure Analysis determines how much of an adulticide people might be exposed to under various conditions during applications.

Toxicity Analysis determines how much of an adulticide is required to cause a toxic effect, and predicts exposure levels at which risk is likely to be negligible or nonexistent.

Risk Characterization integrates the relevant information from the preceding two steps to characterize the risks to the exposed population (i.e., the likelihood that there will be an increase in a particular health effect in the population exposed to a particular adulticide). The risk characterization also includes a description of the assumptions and uncertainties that go into the risk assessment, and an assessment of the overall confidence in the results of the analysis.

As discussed above and in Chapter 2, “Pesticides Regulations and Usage,” detailed information regarding the specific inert ingredients, and their amounts within the adulticides being analyzed, have not been disclosed by the manufacturers. Therefore, the risk assessment, which is a quantitative analysis, can be performed only for the active ingredients within the adulticides. The potential public health effects of the adulticide products as a whole (which include the inert ingredients) will be discussed qualitatively based on the information available in the literature regarding the general categories to which the inert ingredients belong.

**Epidemiologic and Attributable Risk Analyses**

As described in Chapter 3.C “Public Health,” an Epidemiologic Analysis was conducted to examine the possible impacts of adulticiding on asthma exacerbations in New York City. In addition to the epidemiologic analysis, an Attributable Risk Analysis was used to estimate the number of asthma hospitalizations that could potentially be attributed to adulticide application. A more detailed discussion of these analyses is provided in Chapter 3.C, “Public Health.”

**PUBLIC HEALTH CHARACTERISTICS OF PROPOSED ADULTICIDES – LITERATURE REVIEW**

Because adulticides are developed to kill insects, they contain toxic substances that have the potential to affect human health, either through their toxicity or because they irritate or exacerbate sensitivities and allergies, leading to a number of symptoms. Therefore, the assessment of the potential for impacts of the proposed action on public health from the use of insecticides and synergists examines a full range of possible effects, from relatively benign and short-lived skin and eye irritation to serious diseases, such as cancer. The toxicological information discussed for these signs and symptoms does not include data from suicides or willful exposure to pesticides. The public health issues are:

- Skin and eye irritation;
- Gastrointestinal distress;
- Respiratory problems (particularly asthma);
- Immunologic/allergic reactions;
- Multiple chemical sensitivity reactions;
- Acute neurologic effects;
- Cognitive developmental disabilities (including autism);
- Endocrine disruption;
- Developmental/reproductive effects, including birth defects; and
Cancer.

These public health issues are discussed in more detail by adulticide active ingredients in Chapter 3.C, “Public Health,” under the subsection “Public Health Characteristics of Proposed Adulticides—Literature Review.”

RISK TO PUBLIC HEALTH FROM USE OF PROPOSED INSECTICIDES—RISK ASSESSMENT

This section of the EIS uses a modeling approach to assess the potential health effects on the public associated with the application of adulticides to control the adult mosquito population in the Rockaways, in order to determine if they pose a significant human health risk. Risk assessment is a process by which scientists evaluate the potential for adverse health or environmental effects from exposure to naturally occurring or synthetic chemicals, including those in adulticides. The goal of this risk assessment is to provide a rational basis for making decisions about managing the use of adulticides in order to protect human health and the environment. Risk assessment is used as part of the decision-making process to ensure public protection against unacceptable risks and to allow the use of products whose benefits outweigh the risks associated with their use. A risk assessment approach uses existing methods and exposure factors developed by the U.S. Environmental Protection Agency (USEPA) to estimate the risks. Because specific information regarding the inerts (i.e., chemical composition and concentration) was not available for this EIS, a quantitative assessment of the inert ingredients present in the adulticides was not performed in this risk assessment. Furthermore, a quantitative assessment of workers applying the adulticides was also not covered in this EIS. It was assumed that these workers would follow the recommendations for protection as indicated on the adulticides’ labels (i.e., use of personal protection equipment, use of masks and/or respirators, gloves, proper handling of adulticides). Furthermore, these workers fall under the guidelines outlined by the Occupational Safety and Health Administration (OSHA). OSHA concerns itself with the protection of workers health. It should be noted that if applicators don’t follow recommendations on the adulticide label to limit their exposures (i.e., use the appropriate level of personal protective equipment, avoid direct exposure to spray drift, use application rates recommended by adulticide manufacturers), there is a potential for health effects.

The risk assessment consists of four steps: hazard identification, an exposure analysis; a toxicity analysis; and a risk characterization, which characterizes the risks to the exposed population (e.g., what is the likelihood that there would be an increase in cancer in a population exposed to a particular active ingredient in adulticides). A brief discussion of these four steps is provided below. Chapter 3.C, “Public Health,” provides a more detailed discussion of these four steps.

Hazard Identification

In this risk assessment, the chemicals of concern are the active ingredients in the adulticide products that could be applied as part of the Proposed Action.

Overview of Adulticides Active Ingredients Evaluated

The 17 adulticides registered for use in New York State that are considered for application on a community-scale basis in this EIS fall into two major categories: organophosphates and pyrethroids. Of these 17 adulticides, five were chosen for detailed technical analysis (see Chapter 2, “Pesticide Regulations and Usage.”). These five products were those with the highest active-ingredient content or combination of active ingredients and a synergist—piperonyl butoxide (PBO), and the least
A brief description of the adulticide ingredients is provided below. A more detailed discussion of these ingredients is provided in Chapter 3.C, “Public Health.”

**Malathion**
USEPA has classified malathion as a Class III adulticide, slightly toxic to practically non-toxic in mammalian species. Malathion, a commonly used insecticide, is registered for use in the home or garden as well as for professional use.

**Naled**
USEPA has classified naled as a Class II adulticide moderately toxic in mammalian species. Naled is used to control adult mosquitoes and flies, on field crops, and in mushroom houses (Gallo and Lawryk, 1991).

**Permethrin**
Depending on the adulticide formulation containing permethrin, USEPA has classified permethrin as either a Class II (moderately toxic) or III (practically non-toxic to slightly toxic) adulticide (USEPA, 1999b). It is used as a pesticide for a variety of agricultural crops and as a household pesticide to control cockroaches and flying insects. Permethrin is also used for the treatment of extoparasites (parasites on the surface of the body), such as lice living on humans.

**Resmethrin**
Resmethrin is classified by the USEPA in toxicity class II - slightly toxic to practically non-toxic (USEPA, 1999b). It has uses in household and agricultural pesticides as well as for mosquito control.

**Sumithrin**
Sumithrin is used for mosquito control in outdoor areas, as well as in shampoo for treatment of head lice (World Health Organization, 1990b). Unlike permethrin and resmethrin, USEPA has not classified sumithrin as to its toxicity class.

**Piperonyl Butoxide**
Piperonyl butoxide is considered minimally toxic, and is not considered likely to cause significant signs or symptoms of toxicity following short-term oral or skin exposures (Knowles, 1991). USEPA has not classified piperonyl butoxide as to its toxicity class. The addition of piperonyl butoxide to pyrethroid adulticides improves the insecticidal efficacy of pyrethroids by blocking the enzymes responsible for breaking down pyrethroids in insects (Knowles, 1991).

**Inerts**
In addition to active ingredients, the adulticide formulations contain inert ingredients. Because an adulticide formulation is considered classified business information, manufacturers are not required by law to provide information regarding the inerts to the public. However, information regarding inerts is required for federal and state pesticide registration. Furthermore, the types and amounts of inerts are taken into account when establishing use restrictions, to ensure that health will not be adversely affected under conditions of proper use and handling. As discussed in Chapter 2, “Pesticide Regulations and Usage,” since information on the specific inert ingredients was not disclosed by the manufacturers to the New York City Department of Health (NYCDOH) for the purposes of this EIS, efforts have been made to characterize the potential public health effects of these inerts from available information on the general categories of these inerts and product test data found within the available literature. Although these ingredients are inert in terms of insecticidal activity, they may have
toxicological properties. Therefore, exposure to the inert ingredients must also be considered. A detailed qualitative discussion of the potential health effects associated with exposures to inerts is provided in Chapter 3.C, “Public Health.”

**Exposure Analysis**

This is the second step in the public health risk assessment. The purpose of the exposure analysis in this EIS is to determine the amount of adulticides’ active ingredients to which people might be exposed under various conditions during and following spraying. This includes identifying human populations (e.g., child and adult residents, city public workers, children and adults using parks and school playgrounds), exposure pathways (inhalation, ingestion, skin), exposure parameters (e.g., child and adult body weights, fruit and vegetable ingestion rates, amount of time spent indoor and outdoor), adulticide active ingredient concentrations predicted through dispersion and deposition modeling (e.g., concentrations and deposition levels of active ingredients in surface, water, soil, air), and estimates of the amount taken in by people during and following the spraying of adulticides. The Exposure Analysis section includes the following subsections:

- Identification of Human Populations Potentially Exposed.
- Evaluation of Exposure Pathways, which evaluates the routes by which people may come in contact with the adulticides.
- Selection of Exposure Parameters, which presents the rationale for the selection of exposure parameters for the human populations potentially exposed to adulticides.
- Calculation of Exposure Concentrations, which describes the approach used to estimate concentrations of active ingredients in air and deposition levels on surfaces based on dispersion and deposition modeling, in order to quantify potential human exposures to adulticide formulations.
- Calculation of Exposures, which integrates the information developed in the subsections described above, to estimate the amount of adulticides’ active ingredients taken in by people during and following applications.

**Identification of Human Populations Potentially Exposed**

Based on human activities and the various environment types (i.e., residential, commercial, industrial, institutional, and recreational) within the selected representative areas (Neponsit/Belle Harbor, Seaside/Hammels, Somerville/Arverne/Edgemere, and Far Rockaway), several human populations which can potentially be exposed to adulticiding activities are identified for the EIS. To account for the variability in human populations (i.e., age, activity) resulting in the potential variability in exposures to the adulticides, the identified human populations were further broken down into specific age ranges and population subgroups. The following human populations and age groups address these issues:

**Residents:**
- Young Child (0-6 years)
- Older Child, Adolescent and Adult (7 years and older)

**Workers:**
- Commercial/Industrial
- Public Works (i.e., street sweepers, park employees, sanitation department)
Sensitive Groups:
- Hospitalized/In Nursing Homes
- Homeless
- Suffering from Asthma, Multiple Chemical Sensitivity, Autism and Learning Disabilities

School Populations:
- Older Child (7-12 years)
- Adolescent (13-18 years)
- Staff and Teachers (older than 18 years)

Park Visitors:
- Young Child (0-6 years)
- Older child (7-12 years)
- Adolescent (13-18 years)
- Adult (older than 18 years)
- Community Gardener (older than 18 years)

This risk assessment will evaluate the possible effects of adulticide exposure on all these population subgroups and their anticipated environmental settings. Thus, the possibility of various health risks are assessed for several potential age groups, including sensitive members of the population, under a broad range of exposure conditions and activities. While other individuals, in other settings, might be exposed, the groups being discussed here have the greatest potential for exposure. Therefore, if spraying adulticides does not pose a significant health risk to these people, it is not likely to pose a significant risk to others with lower potential for exposure.

Although not directly assessed as a specific group in this public health risk assessment, other human populations, such as developing fetuses and pregnant women, are accounted for by using USEPA-derived toxicity criteria. These criteria include safety factors to account for the variability in sensitivity in human populations. These safety factors account for sensitivity of pregnant women, the elderly, those suffering from chronic illnesses, as well as the developing fetus. This concept is more fully addressed in the subsequent Toxicity Analysis section.

As mentioned earlier, a quantitative assessment of workers applying the adulticides was not performed in this EIS. These adulticides must be applied by appropriately certified and trained applicators and these workers fall under the guidelines outlined by the OSHA.

Evaluation of Exposure Pathways

During adulticide application, there is the potential for the adulticide to drift from the spraying area due to wind and dispersion. Therefore, as discussed earlier in this section, there is the potential for exposure to adulticides in outdoor air and in indoor air, and to adulticide residue on skin, in swimming areas, gardens, and any other surfaces where adulticide particles settle. In certain microenvironments over the spraying period, these deposition scenarios may allow for an adulticide to accumulate and persist for a longer time, depending on the particular adulticide’s break-down rate.

The exposure pathways evaluated for the seven representative areas in New York City as part of the Mosquito-Borne Disease Control Program, are the same exposure pathways considered in this evaluation for the representative areas in the Rockaways, as part of the Mosquito Population Control...
Selection of Exposure Parameters

Selection of exposure parameters (e.g., intake rate, exposure frequency, exposure duration, body weight) are consistent with current USEPA guidance. This multi-pathway exposure assessment is based on standard USEPA exposure assumptions and risk assessment approaches. Consistent with USEPA guidance (1989a), both “central tendency” and “reasonable maximum exposure” (RME) values for the various pathways are evaluated. Central tendency exposure parameters are more typical of average exposure conditions, whereas RME values are defined as reasonable upper-bound exposure conditions. The central tendency and RME values are used to account for the variability in potential exposure for the various human populations evaluated in this assessment. The exposure parameters are presented in Appendix 3.C-1, along with reference citations and the rationale for the selection.

Calculation of Exposure Point Concentrations

To quantify potential human exposures to adulticides, the concentrations and deposition levels of the adulticides’ active ingredients released from the applicator's truck are modeled in air and on surfaces. The exposure point concentration (EPC) is the concentration of an active ingredient in soil, water, surfaces, food, and air with which people come in contact by the various exposure pathways (i.e., it is the amount of active ingredient that one is exposed to from a specific exposure pathway).

For acute (short-term) exposures (e.g., inhalation of drift or skin contact with drift during spraying; incidental ingestion of drift deposited or transferred onto hands), the EPCs are based on the maximum air-model results at a distance of 25 feet from the spray source during a single application of the adulticides.

For subchronic and chronic exposures, the EPCs are based on the average deposition level within a 300-foot swath (treatment area adjacent to the spray source), derived from the deposition modeling results. These deposition levels are modified according to the adulticide application schedule to account for both the accumulation and the degradation of the adulticide in the environment over the course of the selected 90-day spraying period. As described in Chapter 4.A, “Framework of the Analysis,” it is assumed that adulticides could potentially be sprayed approximately twice a month for three months of the year for the Mosquito Population Control Program in the Rockaways. (For this assessment, the much longer application and repeat application assumptions employed for the Mosquito-Borne Disease Control Program were assumed for the Mosquito Population Control Program in the Rockaways program). Over this time period, more and more of the adulticide would accumulate as more was applied, but some of the adulticide would also degrade, or break down.

The resulting subchronic and chronic exposure EPCs in all media (air, water, surfaces, and soil) are determined by combining three things: the spraying schedule; the compound’s media-specific decay rates (i.e., how quickly the active ingredient breaks down or degrades in the environment); and the accumulated concentrations resulting from each additional spraying event. The resulting concentrations are averaged over 182 days (i.e., half a year). These derived 182-day average EPCs expected within 300 feet of the spraying locations are used for assessing subchronic and chronic exposures. A more detailed discussion of the approach used to estimate EPCs for soil, air, surfaces, and water is provided in Appendix 3.C-2.

EPCs, as calculated using methods described in Appendix 3.C-2, are presented in Table 4.C-1. Based on the longer adulticide application schedule from the Mosquito-Borne Disease Control Program
Table 4.C-1  Exposure Point Concentrations in Various Media
which was conservatively assumed for the *Mosquito Population Control Program in the Rockaways*, the resulting EPCs for the various media are approximately 60 percent of the EPCs estimated for the adulticide application schedule outlined in Chapter 3.C, “Public Health.”

**Calculation of Exposures**

As presented in Chapter 3.C, “Public Health,” various equations are used to estimate the amount of adulticides’ active ingredients to which people may be exposed during daily activities at home, at work, or at play following an application to control adult mosquitoes. The adulticides may enter the human body by one of the following exposure pathways, or by a combination of these pathways:

- Inhalation of adulticides in air;
- Ingestion of adulticides in soil, food, and water; and
- Skin contact with adulticides in soil, surfaces, and water.

A more detailed discussion of the equations used to estimate daily exposures is provided in Chapter 3.C, “Public Health,” under the “Calculation of Exposures” subsection of the risk assessment.

**Toxicity Analysis**

This section is the third step in the public health risk assessment. The purpose of the toxicity analysis is to determine how much of an adulticide is required to cause an adverse health effect, and to predict exposure levels at which those health effects are likely to be negligible or nonexistent. Those exposure levels are also called “toxicity criteria.” In this step, two general types of toxicity criteria are developed: the non-carcinogenic (or non-cancer) reference dose and concentration; and the carcinogenic slope factor and unit risk. A complete discussion of the derivation of the toxicity criteria used in this public health risk assessment is provided in Chapter 3.C, “Public Health.”

**Risk Characterization**

In this section, the information developed in the previous sections (“Exposure Analysis” and “Toxicity Analysis”) are combined to describe the likelihood and nature of potential health effects that human populations may experience following exposure to adulticides associated with New York City’s control of adult mosquitoes. The Risk Characterization Section contains the following subsections:

- Evaluation of Non-cancer Health Risks, which describes whether exposure to the active ingredients associated with the control of adult mosquitoes can be associated with any non-cancer health risks as described earlier in this public health risk assessment.
- Evaluation of Cancer Risks, which describes whether exposure to malathion and permethrin can be associated with a significant increase in cancer health risks. (For all other active ingredients in this study, there is either no evidence of carcinogenicity or limited evidence, with no established CSF as determined from the toxicity analysis.)
- Margin of Exposure Analysis, which evaluates cancer risks if there is sufficient evidence that there is a threshold dose for carcinogenic effects.
- Evaluation of Acute Exposures, which describes whether adverse health risks can be associated with exposure to adulticides immediately after application (i.e., contact with spray) or soon thereafter (i.e., in adulticide drift).

A detailed discussion of the Alternative Assumption Analysis is provided in Chapter 3.C, “Public Health,” under the “Risk Characterization” section of the risk assessment.
Evaluation of Non-Cancer Health Risks

Non-carcinogenic health risks are characterized as the increased likelihood that an individual will suffer adverse health effects (excluding cancer) as a result of chemical exposure. The methodology to estimate non-carcinogenic health risks is discussed in more detail in Chapter 3.C, “Public Health,” under the subsection “Evaluation of Non-Cancer Health Risks” in the “Risk Characterization” section of the risk assessment. Presented below in Tables 4.C-2 and 4.C-3 are the non-carcinogenic health risks associated with potential exposure to the adulticide’s active ingredients for the Rockaways’ representative areas.

The HI (hazard index) represents the sum of all potential exposures to a specific active ingredient. Thus, if the HI is less than or equal to 1.0, no adverse non-cancer health effects are expected. An HI greater than 1.0 does not mean that adverse human health effects will occur, but rather that further evaluation is required.

As shown in Tables 4.C-2 and 4.C-3, none of the evaluated human populations (i.e., child and adult residents, workers, homeless people, schoolchildren and teachers, and park visitors and community gardeners) have HIIs exceeding a value of 1.0 for any of the six active ingredients evaluated in this assessment under average or reasonable maximum exposures. Therefore, the results indicate that non-cancer adverse health effects are not expected for any of these exposure scenarios. Although the HIIs are still below 1.0 for naled, potential exposures to naled resulted in the highest ratio, whereas potential exposures to sumithrin resulted in the lowest ratios of all the six active ingredients in adulticides evaluated in this assessment. For example, Table 4.C–2 shows that for the most exposed group—adults exposed over 30 years under reasonable-maximum-exposure conditions—the HI for naled is 0.31, whereas for the same group of adults, the HI for sumithrin is 0.00084. Because of the various safety factors incorporated into the derivation of the non-cancer health criteria to account for the variability in sensitivity of people, including pregnant women, the developing fetus, the elderly, and the chronically ill, non-cancer adverse health effects associated with potential exposures to any of the six active ingredients are not expected even for these sensitive individuals.

Evaluation of Cancer Health Risks

Cancer risks for permethrin and malathion are evaluated using a cancer slope factor (CSF). Although there is some evidence that resmethrin, sumithrin, and piperonyl butoxide may be carcinogenic, cancer slope factors have not been derived for these compounds by the USEPA. Therefore cancer risks for resmethrin, sumithrin, and piperonyl butoxide are evaluated by using a Margin of Exposure (MOE) analysis, as discussed later in this section. As discussed earlier, naled is not considered to be carcinogenic in humans. Therefore, cancer risks for naled are not evaluated.

Carcinogenic risks are characterized as the upper-bound (highest estimated) incremental probability that an individual will develop cancer during his or her lifetime due to chemical exposure. It should be noted that this is a conservative model that may over-estimate the actual risks. The term “incremental” implies that this risk corresponds to the added probability of cancer above the background cancer risk typically experienced by all individuals in the course of daily life. Cancer risks are expressed as a unitless upper-bound probability (e.g., one in a million, or $10^{-6}$) of an individual developing cancer over a lifetime, above the background risk, as a result of the exposure. USEPA has determined an acceptable target risk range of less than 0.000001 (i.e., one in a million) to 0.00001 (i.e., one in ten thousand). The methodology to estimate carcinogenic health risks is discussed in more detail in Chapter 3.C, “Public Health,” under the subsection “Evaluation of Cancer Health Risks” in the “Risk Characterization” section of the risk assessment.
Table 4.C-2   All Populations and Pathways - Summary of Non-Cancer Risks (Average Exposures)
Table 4.C-2 (continued)  
All Populations and Pathways - Summary of Non-Cancer Risks (Reasonable Maximum Exposures)
Table 4.C-3  All Populations and Pathways - Summary of Non-Cancer Risks (Average Exposures)
Table 4.C-3 (continued)  All Populations and Pathways - Summary of Non-Cancer Risks (Reasonable Maximum Exposures)
The Total Excess Lifetime Cancer Risk for each population is determined by adding together the risks for each complete pathway for each population. A summary of total cancer risks for malathion and permethrin are presented in Table 4.C-4 for average exposures, and in Table 4.C-5 for reasonable maximum exposures.

### Table 4.C-4

<table>
<thead>
<tr>
<th>Population</th>
<th>Total Chronic Cancer Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Malathion</td>
</tr>
<tr>
<td><strong>Resident</strong></td>
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<tr>
<td>Child</td>
<td>0.0000000174</td>
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<td>Adult</td>
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<td>Sum for Lifetime</td>
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<td><strong>Worker</strong></td>
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<tr>
<td>Commercial/Industrial</td>
<td>0.00000000378</td>
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<tr>
<td>Public Works</td>
<td>0.0000000041</td>
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<tr>
<td><strong>Homeless</strong></td>
<td></td>
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<tr>
<td>Adult</td>
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<tr>
<td><strong>School</strong></td>
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<tr>
<td>Older Child (6-12)</td>
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<td>Adolescent (13-18)</td>
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<td><strong>Park Visitor</strong></td>
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<tr>
<td>Younger Child (0-6)</td>
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<tr>
<td>Older Child (7-12)</td>
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<td>Adolescent (13-18)</td>
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<tr>
<td>Adult (&gt;18)</td>
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<tr>
<td>Community Gardener (&gt;18)</td>
<td>0.0000000032</td>
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</table>

Carcinogenic risks characterized for the human populations listed above are within or below the USEPA-determined acceptable target risk range of less than 0.000001 to 0.0001 (or from 1 in 1 million to 1 in 10,000.) Although still within an acceptable target risk range, the highest cancer risks for all human populations evaluated in this assessment are associated with exposures to permethrin. The highest estimated cancer risk of 0.0000029 is for residents (“child and adult combined” to describe a child who grows up to be an adult during the spraying period) under reasonable maximum exposures to permethrin. This value is the added probability of getting cancer above the background cancer risk typically experienced by all individuals in the course of daily life. Unfortunately, taken all cancers together, cancer is a fairly common disease. In New York City alone, 30,000 new cases of cancer are diagnosed each year. Generally, the incidence of cancer increases with age and often varies by place of residence, racial/ethnic background and other demographic features of the population. Nationally, cancer is the third leading cause of death. For New York City residents, cancer has been the second leading cause of death for both men and women. The American Cancer Society has determined that the lifetime probability of developing cancer is 43.5 percent (0.435, or one chance in 2.3) in men and 38.3 percent (0.383, or one chance in 2.6) in women (Greenlee et al., 2001). Cancer risks associated with exposures to malathion are approximately 10 to 100 times lower than risks...
associated with permethrin. For malathion, for example, Table 4.C-5 shows that a resident adult (including those belonging to a sensitive population group) who is potentially exposed to malathion under reasonable maximum exposure conditions over a lifetime would have a 0.000000057—or approximately five chances in one hundred million—increased risk of developing cancer.

<table>
<thead>
<tr>
<th>Population</th>
<th>Total Chronic Cancer Risks</th>
<th>Malathion</th>
<th>Permethrin</th>
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</thead>
<tbody>
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<td><strong>Resident</strong></td>
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<td>Child</td>
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<td>Sum for Lifetime</td>
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<td><strong>Park Visitor</strong></td>
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<tr>
<td>Older Child (7-12)</td>
<td>0.000000008</td>
<td>0.000000232</td>
<td></td>
</tr>
<tr>
<td>Adolescent (13-18)</td>
<td>0.000000006</td>
<td>0.000000157</td>
<td></td>
</tr>
<tr>
<td>Adult (&gt;18)</td>
<td>0.000000036</td>
<td>0.000001200</td>
<td></td>
</tr>
<tr>
<td>Community Gardener (&gt;18)</td>
<td>0.000000036</td>
<td>0.000001200</td>
<td></td>
</tr>
</tbody>
</table>

**MOE Analysis**

According to USEPA’s 1996 proposed revised Guidelines for Carcinogen Risk Assessment, a Margin of Exposure (MOE) analysis can be used to evaluate cancer risks if there is sufficient evidence to support that cancer will occur only if an individual is exposed to a dose level that is above what is known as a “threshold dose” (USEPA, 1998e). As long as exposures are below this threshold dose, there should not be any increased cancer risk. A more complete discussion of the MOE analysis is provided in Chapter 3.C, “Public Health,” under the subsection “MOE Analysis” in the “Risk Characterization” section of the risk assessment.

Table 4.C-6 presents the MOEs for sumithrin, resmethrin, and PBO. The calculated MOE is compared to the comparison MOE to determine the potential for increased cancer risk. A calculated MOE greater than the comparison MOE implies that exposure to the particular active ingredient is low enough to not be of concern. A calculated MOE less than the advisory MOE could indicate a potential health risk.

As shown in Table 4.C-6, for sumithrin, resmethrin, and PBO, the MOE analysis indicates that potential exposures to these chemicals by resident children, the most sensitive individuals, are low enough to not be of concern.
Evaluation of Acute Exposures

Acute exposures—those occurring within 24 hours of adulticide spraying—are evaluated using risk-based concentrations (RBCs). RBCs are the concentrations in air that are associated with no adverse health effects. A reference dose (RfD) or reference concentration (RfC) is defined by USEPA as a chemical-specific dose or concentration to which people, including sensitive individuals, can be exposed on a daily basis without adverse health effects. RBCs are calculated using acute (one-day, immediate) toxicity criteria (acute RfCs and RfDs), and represent a maximum exposure level, below which no adverse health effects are expected. A more detailed discussion of the evaluation of acute exposures is provided in Chapter 3.C in the “Risk Characterization” section of the risk assessment.

The RBCs calculated for children in the residential scenario are presented in Table 4.C-7. RBCs are compared to the acute exposure concentrations. As long as the acute exposure concentrations are less than or equal to the RBCs, adverse health effects resulting from acute exposure to the active ingredients being studied are not expected to occur.

As shown in Table 4.C-7, results from this approach indicate that the maximum modeled air concentrations for sumithrin, resmethrin, permethrin and PBO occurring within 24 hours of adulticide spraying are lower (up to 10 times lower) than the calculated RBCs. This would imply that acute exposures to these active ingredients would not result in adverse acute health effects. The results also show that the maximum short-term modeled air concentrations for malathion and naled are higher than the calculated RBCs, which would imply that immediate health effects could potentially result from malathion and naled exposures.
Alternative Assumptions Analysis

The process of evaluating human health risks involves multiple steps. Inherent in each step are uncertainties that ultimately affect the final risk estimates. Uncertainties may exist in numerous areas, including environmental sampling data, derivation of toxicity values, and estimation of potential site exposures. However, where uncertainties exist, conservative inputs or approaches were generally used so that potential risks would be overestimated. A more detailed discussion of the uncertainties in the risk assessment are provided in Chapter 3.C, “Public Health,” under the subsection “Alternative Assumptions Analysis” in the “Risk Characterization” section of the risk assessment.

Public Health Response to Spraying Programs: Recent Experience — Epidemiologic and Attributable Risk Analyses

The methods and results of the Epidemiologic and Attributable Risk Analyses are presented in Chapter 3.C, “Public Health.”

C. OVERALL CONCLUSIONS

For this EIS, potential public health impacts in the Rockaways from the implementation of the Mosquito Population Control Program in the Rockaways were evaluated using three major approaches: Scientific Literature Review; Risk Assessment; and Epidemiologic and Attributable Risk analysis. Each of these three approaches can provide some of the necessary information required in evaluating these potential impacts. Likewise, each has its limitations. However, when these elements are reviewed together, they each contribute to provide a more complete assessment. This can be used to weigh the existing evidence.

Based on the literature reviewed, adverse health impacts from potential exposure to adulticides at the levels associated with mosquito control, are not expected for such public health issues as gastrointestinal distress, neurological effects, cognitive developmental disabilities, endocrine disruption and developmental/reproductive effects. At this time, it is not possible to determine solely from the literature, the potential effects of the adulticides on the immune system and MSC reactions. However, based on the Risk Assessment, exposures to the adulticides at levels expected from application for mosquito control indicate no adverse health impacts for all non-cancer public health issues.

As discussed in the Conclusion sections of the Literature Review, all six of the active ingredients and certain inert ingredients have been linked to skin and eye irritation in humans on direct exposure. However, the risk assessment conducted for this EIS indicated, that for only two active ingredients (malathion and naled), a one-time exposure (i.e. exposure through inhalation, direct skin contact or ingestion) could result in short-term health effects (e.g., skin irritation or respiratory effects) for some sensitive individuals. It should be noted however, that risk assessment calculations were based on conservative exposure assumptions (e.g., direct exposure occurring at 25 feet from the spray truck) and therefore, these exposures are not the exposures anticipated for the general population. However, there may be more highly susceptible subpopulations (e.g., exterminators, gardeners), some of which have pre-existing sensitizations. Although naled was modeled in the risk assessment in the same manner as the other active ingredients (i.e., to yield conservative results, the risk assessment results were based on concentration and deposition values from ground application), ground application of naled is not considered for the Proposed Action. A review of the scientific literature showed that the application of adulticides is not expected to significantly increase the occurrence of asthma events or other respiratory health effects at the low exposure concentrations associated with mosquito control. The epidemiologic analysis for short-term respiratory events found that no conclusions about the
potential relationship between adulticide use and asthma exacerbations can be drawn. The attributable risk calculation predicted that the increase in asthma hospitalizations potentially related to the application of adulticides as part of the Proposed Action would be relatively low among both adults and children with existing asthma.

The analyses described are an attempt at investigating the effects of adulticides on asthma exacerbation. Due to the many limitations of these investigations, these analyses should be viewed as a first step in describing asthma exacerbations during pre- and post-spraying periods. These analyses should not be considered conclusive of a finding of an effect or non-effect. Clearly, analytic approaches need to be developed to determine if any potential effect on asthma exacerbations is the result of adulticide use. Additional epidemiologic research utilizing more sensitive exposure and outcome as well as measures of potential confounders need to be developed.

While there is a possibility that some sensitive individuals may experience health effects within a short period of time following application of adulticides for control of mosquitoes, it is likely that such impacts would be short-term in nature.

Therefore, from evaluation of the results of the three public health analyses mentioned above, it was determined that no significant adverse public health impacts would be expected from exposure to the adulticides when applied for the purposes of the Mosquito Control Program in the Rockaways.

NYCDOH may need to use adulticides to minimize the detriment to quality of life for citizens in the Rockaways from uncontrollably large populations of mosquitoes in future years. The results of this EIS will help inform the department’s decision in selecting which chemical or chemicals to use in adulticiding efforts.
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4.C PUBLIC HEALTH .......................................................................................................................... 4.C-1

A. Introduction ................................................................................................................................. 4.C-1
   Literature Review ......................................................................................................................... 4.C-1
   Risk Assessment ........................................................................................................................ 4.C-1
   Empirical Studies....................................................................................................................... 4.C-1

B. Risk To Public Health From Use Of Proposed Insecticides—Risk Assessment .......... 4.C-3
   Exposure Analysis ....................................................................................................................... 4.C-5
      Overview of Adulticides Active Ingredients Evaluated ............................................................ 4.C-5
      Evaluation of Exposure Pathways .......................................................................................... 4.C-6
      Toxicity Analysis .................................................................................................................... 4.C-9
      Risk Characterization ........................................................................................................... 4.C-9
   Alternative Assumptions Analysis .............................................................................................. 4.C-18


Potential for Adverse Public Health Impacts in Representative Areas of the Rockaways .......... 4.C-18

Seaside/ Hammels Area ................................................................................................................ 4.C-18
Somerville/Edgemere/Arverne Area ........................................................................................... 4.C-18
Far Rockaway Area ...................................................................................................................... 4.C-18

C. Conclusion ................................................................................................................................. Error! Bookmark not defined.

4.C-1 Exposure Point Concentrations in Various Media ................................................................. 4.C-8
4.C-3 All Populations and Pathways - Summary of Non-Cancer Risks (Average Exposures) .... 4.C-13
4.C-5 All Populations and Pathways - Summary of Cancer Risks (Reasonable Maximum Exposures) .... 4.C-17
4.C-6argin of Exposure Analysis (based on resident children) ......................................................... 4.C-17
4.C-7 Evaluation of Acute Exposures ............................................................................................ 4.C-17