EXECUTIVE SUMMARY

INTRODUCTION

In the late summer of 1999, a cluster of unusual encephalitis cases was diagnosed in New York City. The results of a public health investigation determined the cause of these illnesses to be West Nile virus, a mosquito-borne virus never before detected in North America. Over a 2-month time period, 44 New York City residents were hospitalized with West Nile virus illnesses. Four of these residents died. The discovery that a mosquito borne virus was the cause of serious illness led to the rapid implementation of mosquito-control measures. Subsequently, the New York City Department of Health (NYCDOH) began the development of a long-term *Comprehensive Arthropod Surveillance and Control Plan* (the *Comprehensive Plan*).

The *Comprehensive Plan* emphasizes routine surveillance and control of potential mosquito breeding sites to prevent adult mosquitoes from proliferating throughout the City. The *Comprehensive Plan* addresses efforts to control adult mosquitoes to prevent disease throughout the City, if necessary. In addition, in response to community concerns, the *Comprehensive Plan* will include a component to control adult mosquito populations in the Rockaways. The Rockaways are surrounded by marshland inhabited by large numbers of salt marsh mosquitoes. Although these mosquitoes are not currently considered primary vectors for West Nile virus, they do bite humans, and have interfered substantially with the ability of citizens to spend time outdoors. The *Comprehensive Plan* includes the following two major components:

1. *Routine Surveillance and Control Program* (the *Routine Program*), focusing on:
   - Education;
   - Comprehensive surveillance; and
   - Mosquito breeding prevention and larval control activities.
2. *Adult Mosquito Control Programs*. This component of the *Comprehensive Plan* consists of two programs:
   a) A *Mosquito-Borne Disease Control Program* focusing on control of adult mosquitoes for disease control Citywide; and
   b) A *Mosquito Population Control Program in the Rockaways* focusing on control of adult mosquito populations in the Rockaways.

In 2000, NYCDOH issued a determination that the *Routine Program* would not result in an adverse impact on the environment. However, in compliance with State and City environmental review procedures, NYCDOH determined that the *Adult Mosquito Control Programs* component warranted a detailed evaluation of the potential environmental impacts of the methods that would be used to

control adult mosquitoes (e.g., application of pesticides), and that an Environmental Impact Statement (EIS) should be prepared. The Proposed Action for this EIS, which has been prepared by NYCDOH to address these issues, is the adoption of both the *Mosquito-Borne Disease Control Program*, and the *Mosquito Population Control Program in the Rockaways*, the two components of the *Adult Mosquito Control Programs*.

It should be noted that although the proposed long-term mosquito control efforts taken to prevent a recurrence of a West Nile virus outbreak will be subject to assessment in this EIS, NYCDOH used adulticides in 1999 and 2000 to address such a recurrence because of the existence of a public health threat. This emergency response occurred prior to the completion of this environmental review.

In this EIS, the environmental analyses pertaining to the *Mosquito-Borne Disease Program* are presented in Chapters 3.A through 3.V. The analyses pertaining to the *Mosquito Population Control Program in the Rockaways* are presented in Chapters 4.A through 4.V. Chapter 5 addresses the potential cumulative impacts of both these programs. Each chapter discusses the potential impacts from the Proposed Action (implementation of the *Adult Mosquito Control Programs*), as well as future potential impacts if the Proposed Action is not implemented (No Action condition).

NOTE: To provide ease in cross-referencing the information provided in this Executive Summary with the main text of the EIS, the section numbers in the Executive Summary below correspond directly with the chapter numbers in the EIS. The table and figure numbers within the Executive Summary are also consistent with those found in the EIS Chapters.

The full text of the EIS is available on NYCDOH's website: www.nyc.gov/health.

1. DESCRIPTION OF THE PROPOSED ACTION

MOSQUITO FACTS: LIFE CYCLE AND VIRUS TRANSMISSION

Mosquito Species

Mosquitoes belong to the Order Diptera and Family Culicidae. There are approximately 3,100 mosquito species worldwide. Some mosquito species can only breed once a year (univoltine), while others can breed several times in a warm weather season (multivoltine). According to *Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico,* there are 45 species of mosquitoes in New York City. Species found in New York City include: *Culex (Cx.) pipiens* and *Cx. restuans* (multivoltine species considered to be the primary vector for West Nile virus in 1999 and 2000), *Cx. salinarius* (multivoltine), *Cx. territans* (multivoltine), *Ochlerotatus (Oc.) sollicitans* (multi-voltine species considered to be the primary aggressive human-biting mosquitoes on the Rockaway Peninsula), *(Oc.)* (formerly Aedes [Ae.]) *canadensis (*univoltine*), Oc. cantator* (mulitvoltine), *Oc. taeniorhynchus (*multivoltine*), Oc. triseriatus (*multivoltine*), Ae. vexans (*multivoltine*), Anopholes (An.) punctipennis* (multivoltine) and *Psorofora (Ps.) ferox* (multivoltine). A species recently discovered in the region is *Oc. japonicus* (multivoltine).

Table 1-1 lists New York City species that are common in saltwater and freshwater environments, and Table 1-2 describes the four stages in the life cycle of the mosquito.

Male mosquitoes usually emerge before female mosquitoes. Females generally have an estimated life span of one to two months, whereas males only live a few weeks (i.e., they usually die a short time after mating).

Table 1-1
New York City Mosquito Species and Habitats

Species	Saltwater	Freshwater
Cx. pipiens		X
Cx. restuans		X
Cx. salinarius	X	
Cx. territans	X	
Oc. sollicitans	X	
Oc. canadensis		X
Oc. cantator	X	
Oc. taeniorhynchus	X	
Oc. triseriatus		X
Oc. japonicus		X
Ae. vexans		X
An. punctipennis		X
Ps. ferox		X

Source: Rutgers Entomology Department, New Jersey Mosquito Control Association (NJMCA.).

As discussed earlier, some mosquito species (known as univoltine) can only breed once a year. Multivoltine mosquitoes (e.g., *Cx. pipiens*), however, can breed several times (up to seven) in a warm weather season. Mosquitoes usually mate in flight shortly after reaching adulthood, and the females store the sperm until they are ready to fertilize eggs. The male adult mosquito, and some females, feed on nectar and other plant juices. Only the female feeds on the blood from vertebrates, and uses a blood meal to nourish development of her eggs.

Table 1-2
The Four Stages of the Mosquito Life Cycle

Stages of Metamorphosis	Habitat	Nourishment	Behavior
Stage 1: Egg	Eggs laid on surface of fresh or stagnant water,* or laid singly on damp soil or vegetation.	Egg does not feed.	Larvae hatch in water.
Stage 2: Larvae (wigglers)	Aquatic; use breathing tube (siphon) to obtain oxygen at water's surface.	Filter feeds on microorganisms. Jaws have brushes that create currents to move food into the mouth.	Molts its exoskeleton 4 times (stages between molts called instars). After 4th Molt, becomes Pupae.
Stage 3: Pupae (tumblers)	Aquatic; floats at surface of water; obtains oxygen through two tubes (trumpets).	Does not feed. Has no mouth.	Takes a few days to transform into adult.
Stage 4: Adult	Terrestrial, Marshes, Woodlands, around human habitations.	Males and females feed on nectar. Females need blood meal for maturation of eggs. Females bite birds, other animals and humans.	Splits pupal case, rests until dry and wings harden.

Notes: *Depending on availability of water, eggs may hatch within a few minutes or lay dormant for years before they emerge as larvae (Source: Lee County Mosquito Control District)

Sources: Rutgers Entomology Department, NJMCA, 2000; Newsday, June 20, 2000 (reference: The American Mosquito Control Association; World Book Encyclopedia); Milne and Milne, 1980; Gillette, 1972.

Female mosquitoes seeking a blood meal are attracted to perspiration, warmth, body odor, carbon dioxide, and light.

Mosquitoes as Virus Vectors

A virus has been defined as "an infectious agent having a simple acellular organization with a protein coat and a single type of nucleic acid, lacking independent metabolism, and reproducing only within living host cells." Arthropod-borne viruses (i.e., arboviruses) are viruses that are maintained in nature through biological transmission between susceptible vertebrate hosts by blood feeding arthropods.

If a mosquito bites an animal that is infected with the West Nile virus, the mosquito can become a carrier of the virus and can transmit it to other animals (including humans) by means of a subsequent bite. If this occurs, the mosquito is considered a vector for the virus. West Nile virus is an arboviral infection that can result in clinical manifestations ranging from no observable symptoms, to mild illness with fever and headache, to more severe illnesses including encephalitis (inflammation of the brain) and/or meningitis (inflammation of the lining surrounding the brain and spinal cord).

The public health investigations and surveys conducted in 1999 and 2000 show that persons more susceptible to developing severe neurologic disease if infected with West Nile virus are people over 50 years of age. Younger people are less likely to be severely affected from exposure to this virus. There are approximately 100 to 200 asymptomatic (infected but not having symptoms) cases for every severe case of West Nile virus.

In addition to the human deaths caused by the West Nile virus since 1999 in New York State, the virus has caused deaths in birds, horses, bats, squirrels, chipmunks, rabbits, and raccoons. Table 1-5 presents the number of positive cases of West Nile virus found among humans, birds, mosquito pools, and horses in North America in 2000.

DEVELOPMENT OF THE COMPREHENSIVE ARTHROPOD-BORNE DISEASE SURVEILLANCE AND CONTROL PLAN 2000

In coordination with the U.S. Centers for Disease Control and Prevention (CDC) and the New York State Department of Health (NYSDOH), NYCDOH developed a *Comprehensive Arthropod-Borne Disease Surveillance and Control Plan for 2000* (*Comprehensive Plan for 2000*). These efforts resulted in the development of the *Routine Program* (discussed in further detail below), which emphasized surveillance, education and larviciding efforts, and were directed at minimizing the known vectors of a potential West Nile virus outbreak in 2000, as well as a component to control adult mosquitoes, in the event of a public health threat despite preventive measures under the *Routine Program*. Also included in the *Comprehensive Plan for 2000* was a component that addressed monitoring for potential pesticide related health effects.

2000 NEW YORK CITY WEST NILE ENCEPHILITIS OUTBREAK AND RESPONSE

In 2000, bird and mosquito testing indicated that West Nile virus had become established throughout much of the northeastern United States. Birds infected with West Nile virus were identified as far north as Vermont and as far south as North Carolina—representing a three-fold increase in the geographic area affected by the virus compared with 1999. The re-emergence of West Nile virus in New York City in 2000 resulted in 14 human cases, including two deaths attributable to contracting the virus in 2000. The center of West Nile activity in 2000 was Staten Island, where 10 of the City's 14 human cases occurred.

Table 1-5:
West Nile Virus Positive Test Results in the United States for Year 2000

Location	Hospitalized Human Cases *	Mosquito Pools	Birds	Horses
New York State Total	14	360	1,278	19
New York City	14	170	179	3
New Jersey	6	57	1,289	27
Connecticut	1	14	1,117	7
Delaware	0	0	1	4
Massachusetts	0	4	448	1
Pennsylvania	0	46	32	1
Rhode Island	0	0	87	1
North Carolina	0	0	1	0
New Hampshire	0	0	7	0
Maryland	0	0	50	0
Washington, D.C.	0	0	5	0
Vermont	0	0	1	0
Virginia	0	0	7	0
Maine	0	0	0	0
Totals	**35**	**651**	**4,502**	**63**

Note: In addition, 6 wild mammals (1 in Connecticut and 5 in New York State) were also classified as West Nile virus positive.
* - does not include cases identified through seroprevalence surveys.
Source: USDA Animal and Plant Health Inspection Service Update on the Current Status of West Nile Virus, Final Report—Year 2000.

2000 Actions Under the Routine Program

The 2000 NYCDOH actions under the *Routine Program* included Vector Surveillance, Vertebrate (Animal) Surveillance, Human Surveillance (including a serosurvey), Education and Outreach (including Public Education and Outreach and Medical Provider Education and Outreach), Mosquito Prevention and Larvae Control Activities, and Research and Evaluation.

2000 Actions to Control Adult Mosquitoes

These actions included Adult Mosquito Control through the use of adulticides, Monitoring Exposures to Mosquito Control Products (including the monitoring of calls that were made during times of adulticide spraying to the New York City Poison Control Center), and Research and Evaluation (including preliminary studies to assess the efficacy of adult mosquito control).

DEVELOPMENT OF NYCDOH'S LONG-TERM COMPREHENSIVE ARTHROPOD SURVEILLANCE AND CONTROL PLAN

Routine Program

In response to concerns about mosquito-borne diseases, NYCDOH has implemented the *Routine Program*, a component of the NYCDOH's long-term *Comprehensive Plan*. Through the creation of the *Routine Program*, the City devotes considerable resources to a Citywide effort to control mosquito breeding while enhancing existing disease surveillance and public and medical provider education activities. The mission of the *Routine Program* is to prevent and reduce the potential for diseases carried by mosquitoes and to detect the West Nile and other arboviruses before there are human cases.

The *Routine Program* is designed to focus resources beginning early in the mosquito season to monitor and reduce the potential for a disease outbreak. The reduction of potential mosquito breeding sites combined with larviciding efforts will reduce the potential for outbreaks and, therefore, the type and extent of adulticides needed in the event of an outbreak. NYCDOH's primary efforts include an aggressive public health campaign to make residents and businesses aware of ongoing City efforts and how they can help to eliminate potential breeding areas, as well as actions to reduce breeding, and larval control activities.

Key activities in the *Routine Program* also include:

- A comprehensive surveillance program for vectors (e.g., larval and adult mosquitoes which may transmit diseases) and arboviral diseases in vertebrates, including humans.
- An education program for health providers and the general public.
- Mosquito prevention and larval control activities.
- A research and evaluation program on the West Nile virus and efficacy of larval control activities.

Adult Mosquito Control Programs

In April 2000, NYCDOH determined, under City Environmental Quality Review (CEQR), that the *Routine Program* would not have the potential for significant adverse impact on the public health or the environment, and issued a Negative Declaration for this component of the *Comprehensive Plan*. For the *Adult Mosquito Control Programs*, which could include focused and/or Citywide truck and/or aerial applications of adulticides, NYCDOH issued a Positive Declaration and determined that an EIS should be prepared to assess the potential environmental impacts of adulticiding, before adopting the *Adult Mosquito Control Programs*, which is the Proposed Action for this EIS.

THE PROPOSED ACTION

The *Adult Mosquito Control Programs* consist of two components:

- A *Mosquito-Borne Disease Control Program*; and
- A *Mosquito Population Control Program in the Rockaways*.

The goals of the *Adult Mosquito Control Programs* would be to:

- Protect New York City's residents, workers, and visitors from a recurrence of a West Nile virus outbreak (or other mosquito-borne disease outbreaks that might occur in the future);
- Protect the environment from the potential adverse effects from the application of adulticides, should all of the preventive efforts under the *Routine Program* prove ineffective; and
- Control the adult mosquito population in the Rockaways.

A number of application mechanisms, including backpack, all-terrain vehicles (ATVs), truck or aerial spraying, may be used to apply adulticides. Federal and State laws require the registration of insecticides (both larvicides and adulticides). As part of these Federal and State laws, labels are provided for each product. As mandated under Federal and State law, all insecticide label directions, precautions and restrictions must be followed. Appendix 1 provides the labels and Material Safety Data Sheets (MSDSs) for the adulticides under consideration for community-scale applications. In the

event that spraying of adulticides becomes necessary, the City will monitor for adverse environmental and human health effects of the spraying.

Mosquito-Borne Disease Control Program

One of the goals of the *Mosquito-Borne Disease Control Program* is to protect public health by reducing the potential for the amplification of viruses in mosquitoes that have been identified as vectors of human disease. The Proposed Action is one component of an integrated pest management program that NYCDOH has proposed to prevent and reduce human health risk from mosquito-borne diseases.

The *Mosquito-Borne Disease Control Program* is based on the latest understanding of the transmission of West Nile virus and other emerging mosquito-borne pathogens, and of the threat of diseases to the residents and workers of New York City from such pathogens. Given the recent outbreak of West Nile virus in the region, the science of surveillance for determining the optimum methods for deciding when to adulticide in a given year is still under development. NYCDOH will continue to stay up to date on the latest research with respect to the unfolding new science of better understanding how the amplification of West Nile virus (and other mosquito-borne diseases) progresses.

The comprehensive vector, bird and human data collected in 2000 have allowed NYCDOH to develop more sensitive surveillance criteria for determining the level of West Nile viral activity in birds and mosquitoes that indicate a significant risk for a human outbreak. In 2001, NYCDOH will monitor these indicators on a Citywide basis to identify areas at risk for human transmission.

NYCDOH has developed guidelines for a phased response to surveillance findings. Because there is recent historical evidence of West Nile virus, it is possible that New York City will experience a recurring outbreak of arboviral encephalitis in the future. Therefore, NYCDOH is conducting Citywide enhanced surveillance, public education, and mosquito breeding prevention activities. Sporadic West Nile virus findings will trigger more intensive community-specific surveillance, public education, source reduction and larviciding. Close tracking of dead bird reports will allow the City to further prioritize for enhanced control activity in those areas of the City where there is early evidence of recurrence of the virus. Evidence of dead bird clusters will prompt increased testing of birds and additional mosquito pool collections and testing in conjunction with intensive preventive control measures (e.g., larval source reduction and larval control).

Further evidence of increasing West Nile viral activity at a level to be of significant human health risk, despite aggressive preventive measures, will trigger the consideration of adult mosquito control, especially in nearby green areas (e.g., parks, cemeteries, golf courses, etc.) where amplification of the virus as a result of mosquito/bird transmission is most likely. Indicators that will be monitored include the overall number or clustering of dead birds reported, the positivity rates among dead birds and mosquitoes tested for West Nile viral infection, or escalating mammalian cases. Positive viral tests in bridge vectors (mosquitoes that serve as primary transmitters of the virus between birds and humans) will be of particular concern.

NYCDOH will work closely with Federal and State partners to assess the risk of an outbreak of human disease and the need to apply pesticides in a limited and targeted area to control adult mosquitoes by considering habitat; time of year; weather conditions; the level of documented virus; the distribution, density, age and infection rate of the vector population; and the density and proximity of human population.

If an outbreak were in progress—with multiple confirmed cases in humans and conditions that favor continued transmission—adult mosquito control for a larger area of the city would be considered.

If the threat of human illness makes spraying necessary:

- Spraying will be concentrated in areas most at risk for disease occurrence.
- Adulticiding will be conducted by applicators meeting U.S. Environmental Protection Agency (USEPA) and New York State Department of Environmental Conservation (NYSDEC) requirements. As part *of the Mosquito-Borne Disease Control Program*, NYCDOH is proposing to maintain a 100-foot buffer around open waterbodies during application of adulticides by truck and a 300-foot buffer around waterbodies during application of adulticides by means of aircraft.
- The City will continue to review available information on the health impact of pesticides. Any pesticide will be applied in compliance with City, State, and Federal laws and regulations.
- The public will be notified of spray schedules in advance, which should allow sufficient time to take any necessary precautions to reduce pesticide exposure.
- Hospitals will be notified regarding the spraying schedule and information on the pesticide that will be used will be provided to the public and to physicians and other health-care providers.
- NYCDOH will monitor and assess control activities for any potential environmental and health effects through several measures, including pre- and post-spray environmental sampling and addressing pesticide exposure complaints received by NYCDOH.
- For quality assurance purposes, a private contractor, independent of the vendor applying pesticide, will assist NYCDOH in assuring that the technical elements of pesticide application are conducted according to plan and pursuant to applicable regulations.

Mosquito Population Control Program in the Rockaways

In response to community concerns about the quality of life for citizens in the Rockaways, NYCDOH has prepared, under the long-term *Comprehensive Plan,* the *Mosquito Population Control Program in the Rockaways*. NYCDOH has received numerous correspondence and reports regarding the unbearable infestation of mosquitoes in the Rockaways during the summer months. Individual residents, representatives of home owner associations, and elected officials including members of Congress, the State Assembly, City Council members, local community boards and the Queens Borough President have reported that large numbers of biting mosquitoes result in residents limiting outdoor recreation and routine activities. For example, it has been reported that, at times during the summer, sitting in yards, holding little league practices, attending outdoor parties and barbecues, gardening, playing outdoors, and enjoying area parks are not possible due to the presence of biting mosquitoes.

It should be noted, that the primary salt marsh mosquito present in the Rockaways, is not currently considered a vector for West Nile virus. The goal of the *Mosquito Population Control Program in the Rockaways* is to minimize the detriment to quality of life for residents, and visitors to the Rockaways, from uncontrolled large populations of mosquitoes.

This program contains elements under both the *Routine Program* and the *Adult Mosquito Control Programs* of NYCDOH's long-term *Comprehensive Plan*. To consider all Rockaway-specific

elements from both programs (*Routine Program* and *Adult Mosquito Control Programs*) in one document, NYCDOH has combined these elements into the recently published *Mosquito Population Control Program in the Rockaways, 2001*. Although this program name is used to describe the Rockaways-specific aspects of both programs, for the purposes of this EIS, the *Mosquito Population Control Program in the Rockaways* refers to the *adult* mosquito control portion only.

The elements of this program include the following:

- NYCDOH will carry out strategic applications of adulticides when necessitated by high numbers of mosquitoes in traps placed throughout the Rockaways Peninsula; and/or upon receipt of a pattern of complaints from the public that indicate unacceptably high levels of biting activity, which can be subsequently documented by NYCDOH staff.
- If adult mosquito control becomes necessary, it will be scheduled when mosquitoes are most active (between dusk and dawn) and weather conditions are conducive to spraying.
- Adult mosquito control will be conducted in a hierarchical manner depending on the acreage involved and expected effectiveness of spray operations. With the program's emphasis on surveillance and targeted control measures, NYCDOH expects to apply adulticides to specific localized areas of the Peninsula via a truck mounted with a cold aerosol generator.
- Information about adulticide spraying days and times will be released 48 hours in advance through the media, the NYCDOH Web site and West Nile Virus Information Line and pertinent City and community organizations.
- NYCDOH will monitor and assess control activities for any potential environmental and health effects through several measures, including pre- and post-spray environmental sampling and addressing pesticide exposure complaints received by NYCDOH.

The *Mosquito Population Control Program in the Rockaways* will not be implemented at Breezy Point or on any other Federal- or State-owned properties, which would minimize the potential impacts to endangered species in these areas. With respect to the Rockaway Beach area, the City would minimize impacts by maintaining at least a 100-foot setback from the landward edge of the dune habitat where breeding habitats have been identified.

2. PESTICIDE REGULATIONS AND USAGE

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pesticides can include insecticides that target insects, fungicides that target fungi, herbicides that target weeds and other unwanted plants, and rodenticides that target rodents, among others. Insecticides include adulticides that target adult mosquitoes, and larvicides that target mosquito larvae and pupae. Under the Proposed Action, NYCDOH could select an adulticide product from among several registered adulticides for its *Adult Mosquito Control Programs.*

NYSDEC pesticide registration information discussed below was largely excerpted from the "Agenda for NYSDEC Division of Solid & Hazardous Materials, Bureau of Pesticides & Radiation, Pesticide Product Registration Workshop, December 12, 1995," and NYSDEC's website (www.dec.state.ny.us). The Code of Federal Regulations (CFR), which codifies the rules established by Federal agencies, and the USEPA's website, are the primary sources of information for the discussion on USEPA's pesticide registration process. The CFR provisions referred to in this chapter (e.g., 40 CFR Part 152, may be found on the Internet at www.access.gpo.gov/nara/cfr/waisidx_00/40cfrv11_00.html).

In order for a pesticide to be distributed, sold, or used in the United States, it must first undergo rigorous registration processes at the Federal and State levels. Products must first be registered with USEPA before NYSDEC conducts its registration process. At each level throughout the process, the potential adverse impacts from pesticides are examined, and in the end, a series of restrictions are applied to the products to make sure that potential adverse effects are minimized.

This section provides an overview of NYSDEC and USEPA pesticide registration processes. It is important to note that NYSDEC has one additional pesticide registration procedure that USEPA does not have: the "Registration to Meet Special Local Needs." Furthermore, the New York State legislature requires the NYSDEC Commissioner to register pesticides independently of the Federal registration process and adopt rules and regulations that, among other things, prevent damage or injury to wildlife. USEPA weighs the risks of using a particular pesticide against possible advantages in a cost-benefit analysis. The parameters that result in a favorable cost-benefit on a national scale might be unfavorable on a local scale. Therefore, it is necessary for New York State to reexamine USEPA decisions on products that successfully pass the Federal registration process in order to protect human health, the environment, and the fish and wildlife resources of the State, as required by State law. Products that are not registered for use as pesticides by USEPA may not be registered for use as pesticides by NYSDEC. The following sections describe USEPA and NYSDEC registration processes in more detail.

Registration assures that pesticides will be properly labeled and that, if used in accordance with USEPA specifications, will not have any unreasonable adverse effects on humans, the environment and non-target species. Through this process, USEPA and NYSDEC examine the composition of each pesticide to determine the effects of its "active" and "inert" ingredients. Unlike active ingredients, inert ingredients are not required to be identified on the product label; only the total percentage of all inert ingredients must be publicly disclosed. In general, detailed information on inert ingredients is considered confidential business information for proprietary purposes and is not available to the public, nor to local health departments.

Many tests are conducted as part of the pesticide registration process to determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish and plants, including endangered species and non-target organisms, as well as possible contamination of surface water or groundwater from leaching (soaking into the ground), runoff (surface drainage following rain event), and spray drift. Testing for the pesticide's environmental effects enables the USEPA to understand its "environmental fate," or persistence within the environment. Potential human risks evaluated include short-term toxicity and long-term effects such as cancer and reproductive system disorders. USEPA must also approve the language that appears on each pesticide label. Some of the language that appears on the label, such as "warning" or "caution," is required based on the product's toxicity. A pesticide product can only be stored, handled, used, and disposed of according to the directions on the label accompanying it at the time of sale.

During the registration process, USEPA classifies pesticide products for restricted use or for general use. General use pesticides may be applied by anyone, but restricted use pesticides may only be applied by certified applicators or persons working under the supervision of a certified applicator. Unclassified pesticides are not limited in any manner, except in cases where a product bears labeling limiting the use to a specific user group such as veterinarians.

NYSDEC Pesticide Registration Process and Reporting Law

New York State's Environmental Conservation Law (ECL) §33-0701 requires every pesticide product used, distributed, sold, or offered for sale in New York State to be registered with NYSDEC.

NYSDOH assists NYSDEC in making decisions on pesticide registrations in the State. The departments conduct joint reviews of applications that would potentially increase the exposure of humans and the environment to a particular pesticide. The departments assume responsibilities according to their area of expertise; NYSDOH evaluates the pesticide product's human health risks while NYSDEC evaluates the risks to the environment and non-target organisms. The joint reviews are conducted for products that contain new active ingredients and products with a major change in labeling or a major change in use pattern.

The New York State Pesticide Reporting Law (PRL), enacted on July 8, 1996, requires certified commercial applicators of restricted use pesticides and commercial permit holders (i.e., anyone involved in the distribution, sale, or re-sale of restricted use pesticides) to submit annual reports to the NYSDEC detailing their pesticide activities for the prior year. Cornell University currently assists NYSDEC in organizing the data in a computer database and summarizing it in annual reports.

Commercial permittees are not required to report sales of pesticides classified for "general use" (e.g., "over-the-counter" household products), with the exception of general use agricultural pesticides. General use pesticides are available for purchase and use by the general public. Therefore, they may be applied by anyone—unlike restricted use pesticides, which must be applied by commercial applicators meeting specific NYSDEC requirements. Commercial applicators are required to report their use of both restricted and general use pesticides.

New York State

As reported in the NYSDEC Preliminary Annual Report on New York State Pesticide Sales and Applications for 1999 (the 1999 Preliminary Report), approximately 13 million gallons and 20.5 million pounds of restricted use pesticides were applied Statewide in 1999, including 3,022 pesticide products.

New York City

The 1999 NYSDEC Preliminary Report indicates that almost 6.7 million gallons plus 3.4 million pounds of restricted use pesticides were used by commercial applicators within New York City. The largest amount of restricted use pesticides was applied in Brooklyn (4.3 million gallons and 2.3 million pounds). To date, there are no comprehensive studies that show actual background use of all pesticides (including those used by the general public), specifically in New York City. As discussed above, general use or "over the counter" pesticide products used by the general public are not required to be reported.

Larvicides

As part of the NYCDOH's *Routine Program*, larvicides are applied to known and potential mosquito breeding sites throughout the City, including catch basins, storm drains, and the borders of stagnant fresh water ponds, as well as wetlands and salt marshes. The larvidicing activity, which is based on the results of active surveillance of potential breeding sites, is started at the beginning of the breeding season in order to reduce the number of adult mosquitoes, thereby decreasing the potential need for adulticides. In 2000, New York City applied approximately 85,400 briquets of the methoprene-based larvicide called Altosid XR Briquets, approximately 4,700 pounds of Vectolex CG Biological Larvicide, and 27 briquets of Bactimos Briquets.

Adulticides

In 1999, approximately 5,349 gallons of four adulticide products were applied by New York City during its public health mosquito-spraying program. Of this amount, the product called Fyfanon

(containing malathion as the active ingredient) constituted 85 percent or 4,561 gallons. In the following year, 2000, New York City applied approximately 2,120 gallons of just one adulticide product called Anvil 10+10 ULV[1] (containing sumithrin as the active ingredient). Of this amount, nearly 56 percent (1,174 gallons) was applied in Staten Island. In 2000, Staten Island was the epicenter (i.e., location of the first human infection and most of the human cases) of the West Nile virus outbreak. In 1999, however, Queens was considered to be the epicenter and therefore received the bulk of the adulticide applications.

In 1999 over 1,200 times more restricted-use pesticides were applied throughout the City as compared to the 5,349 gallons of adulticides applied for the public health mosquito-spraying program. The adulticides represented a mere 0.08 percent of all restricted use pesticides applied throughout the City (for the purposes of home roach control, rat and mouse control, etc.) during the same year (almost 6.7 million gallons). Data on applications of restricted-use pesticides for the year 2000 are not available at this time. Again, there are no studies of actual background use of all pesticides in New York City (including those applied by the general public). The amounts reported to NYSDEC do not include use of pesticides by the general public (e.g., household products).

Adulticides That Would Likely Be Used for Community-Scale Applications

Table 2-9 below lists 17 adulticide products registered for use in New York State that are indicative of products that could be applied on a community-scale basis. While the State's pesticide laws do not make a distinction between pesticides applied on a community-scale basis and those applied to small areas, these 17 products are generally considered more likely for community-scale use. All 17 products were considered for evaluation in the EIS because the Proposed Action is a long-term plan. While NYCDOH applied a pyrethroid product (i.e., Anvil) in 2000, and intends to continue to use pyrethroid products in 2001 (if necessary), there may be a need to choose an organophosphate product at some time in the future. Reasons for possible changes in the selection of a product would include the potential effectiveness of the adulticide on the mosquito specie(s) of concern (either for amplification of the virus in the wildlife hosts or transmission to humans), and the potential for or indication of resistance in species to continued use of the same active ingredient (or product). Therefore, the EIS addresses the potential impacts from all registered adulticides which would likely be used on a community-scale in the foreseeable future. The adulticides are classified into two major categories based on their active ingredients: organophosphates and pyrethroids. The organophosphate products listed below contain one of the following active ingredients: malathion or naled, which represent 2 of almost 40 different types of organophosphate compounds. Not included in Table 2-9 are three pyrethrin products. As compared to organophosphates and pyrethroids, pyrethrins are less likely to be used for community-scale applications because they are expensive and difficult to produce in large quantities. Pyrethrin is a naturally occurring insecticide derived from the flowers of chrysanthemum plants. The pyrethroid products are based on pyrethrin's synthetic equivalent. These products contain the synergist PBO in addition to the pyrethroid ingredient. (A synergist is a chemical that enhances the effectiveness of another chemical.) There are three types of pyrethroid ingredients found in the products listed below: sumithrin, permethrin, and resmethrin.

The 17 adulticide products also contain inert ingredients. Active ingredients are those intended to target and eradicate the pest whereas inert ingredients, comprising the remainder of the product, are used as solvents or to facilitate dispersion of the product.

[1] ULV=Ultra low volume

Information on the specific inert ingredients in the organophosphate products is not available. Only the proportion of inert ingredients appears on each product's label and MSDS. As discussed above, organophosphate products generally contain a small percentage of inert ingredients (with the exception of Formula MU-17, which contains up to 80 percent inerts) as compared to the pyrethroid products. The amounts of inerts found within organophosphate products range between 4 percent (Atrapa Insecticide VCP) and 80 percent (Formula MU-17). Since organophosphates are typically applied at technical grade and pyrethroid products have much larger percentages of inerts, throughout this EIS, the discussion and analysis of impacts from inerts in the products are presented under the pyrethroid products sections.

A review of each product's MSDS indicates that pyrethroids generally contain petroleum-based inert ingredients called "petroleum distillates," which are also known as "hydrocarbons" or "petro-chemicals." Petroleum distillates include a broad range of compounds that are extracted by distillation during the refining of crude oil. They contain both "aromatic" hydrocarbons (they have an odor and include a chemical structure with carbon rings) and "aliphatic" hydrocarbons (they are odorless and have a chemical structure with straight carbon chains). Examples of the types of petroleum distillates found in the pyrethroid products include:

Table 2-9
Adulticides Currently Registered in New York State that could be Applied on a Community-Scale Basis

Product	Active Ingredients and Synergists*	USEPA Registration Number
ORGANOPHOSPHATES		
Atrapa Insecticide VCP	Malathion	1812-407
Atrapa Insecticide ULV	Malathion	1812-407
Dibrom Concentrate Insecticide	Naled	59639-19
Formula MU-17	Naled	5011-71
Fyfanon ULV Ultra Low Volume Concentrate Insecticide	Malathion	4787-8
Trumpet EC Insecticide	Naled	59639-90
PYRETHROIDS		
Anvil 2+2 ULV	Sumithrin, PBO	1021-1687-8329
Anvil 10+10 ULV	Sumithrin, PBO	1021-1688-8329
Aqua-Reslin	Permethrin, PBO	432-796
Biomist 1.5+7.5 ULV	Permethrin, PBO	8329-40
Biomist 3+15 ULV	Permethrin, PBO	8329-33
Mosquito Beater 2-2	Permethrin, PBO	4-389
Flit 10 EC	Permethrin	4816-688-8329
Mosquito Beater 4-4	Permethrin, PBO	4-390
Permethrin 57% OS	Permethrin	8329-44
Scourge Insecticide with SBP-1382/PBO 4%+12% MF Formula II	Resmethrin, PBO	432-716
Scourge Insecticide with SBP-1382/PBO 18%+54% MF Formula II	Resmethrin, PBO	432-667

* New York State Pesticide Product Ingredient and Manufacturer System (PIMS) database http://pmep.cce.cornell.edu/pims/index.html
PBO=Piperonyl Butoxide, which is neither an active ingredient nor an inert ingredient but a synergist.

- Anvil 2+2 and 10+10: white mineral oil and aromatic hydrocarbons
- Aqua-Reslin: odorless mineral spirits
- Mosquito Beater 2-2 and 4-4: aromatic solvent carrier, parafinic solvent carrier
- Scourge Insecticide: aromatic petroleum solvent

Petroleum distillates are found in a wide variety of consumer products, including lip gloss, liquid gas, fertilizer, pesticides, furniture polish, plastics, paint thinners, and motor oil, among many others.

Pesticide products are classified into four categories, based on their relative "acute toxicity" or the health effects that would arise soon after short-term exposure. Category I refers to the most toxic products and requires the label to contain the words "Danger" and possibly "Poison." Category IV refers to the least toxic products, which must bear the word "Caution." When a product is deemed potentially hazardous to the environment, excluding humans and domestic animals, environmental hazard statements are required on the label.

Table 2-12 identifies: (1) the product's toxicity classification, which is based on the product's acute toxicity to humans and domestic animals; (2) the required human hazard warning, which is based on the toxicity classification and is shown on the label; and (3) the environmental hazard statement that is shown on the label.

Adulticide Composition

Active Ingredients

Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), an active ingredient is defined as one that prevents, destroys, repels or mitigates a pest, or is a plant regulator, defoliant, desiccant or nitrogen stabilizer.

The 17 New York State registered products that could be applied on a community-scale basis each contain one of the following active ingredients: naled or malathion (organophosphates); or permethrin, resmethrin or sumithrin (pyrethroids). While the products and their specific formulations may be relatively new, the active ingredients have been used as pesticides for many years.

Organophosphates

Malathion (CAS # 121-75-5)

Malathion, introduced in 1950, is one of the earliest organophosphate insecticides developed. It is suited for the control of sucking and chewing insects on fruits and vegetables, and is also used to control mosquitoes, flies, household insects, animal parasites, and head and body lice. Malathion is available in emulsifiable concentrate, wettable powder, dustable powder, and ultra low volume (ULV) liquid formulations. Malathion may also be found in formulations with many other pesticides. Malathion is also used for adult mosquito control in public health programs like NYCDOH's proposed *Adult Mosquito Control Programs*.

Naled (CAS # 300-76-5)

Naled, initially registered by USEPA in 1959, is a fast acting organophosphate insecticide used to control aphids, mites, mosquitoes, and flies on crops and in greenhouses, mushroom houses, animal and poultry houses, kennels, food processing plants, and aquaria. Liquid formulations can be applied to greenhouse heating pipes to kill insects by vapor action. It has been used by veterinarians to kill parasitic worms (other than tapeworms) in dogs. Naled is available in dust, emulsion concentrate, liquid, and ULV formulations.

Pyrethroids

Permethrin (CAS # 52645-53-1)

Permethrin was developed in 1973 as the first synthetic pyrethroid that is relatively stable in sunlight. It is a broad-spectrum synthetic pyrethroid insecticide, used against a variety of pests on nut, fruit, vegetable, cotton, ornamental, mushroom, potato, and cereal crops. It is used in greenhouses, home gardens, and for termite control. Permethrin is also used as a household pesticide to control cockroaches and flying insects, and for the treatment of ectoparasites (parasites on the surface of the body) such as lice living on humans. It may cause a mite buildup by reducing mite predator populations. Permethrin is available in dusts, emulsifiable concentrates, smokes, ULV, and wettable powder formulations. For adult mosquito control, ULV applications are typically used.

Resmethrin (CAS # 10453-86-8)

Resmethrin, first developed in 1968, is a synthetic pyrethroid and is used for control of flying and crawling insects in homes, greenhouses, indoor landscapes, mushroom houses, and industrial sites. It is also used for fabric protection, pet sprays and shampoos, and it is applied to horses or in horse stables.

Table 2-12
Characteristics of Adulticide Products

Product Name	USEPA Reg. #	% Active Ingredients/ % Inert Ingredients*	Mandatory Labeling (40 CFR Part 156)		
			Toxicity Category**	Human Hazard Warning	Environmental Hazard Statement
ORGANOPHOSPHATES					
Atrapa Insecticide VCP	1812-407	96.5% Malathion/3.5% Inerts	III or IV	Caution	"This pesticide is toxic to fish, aquatic invertebrates, and aquatic life stages of amphibians." ***
Atrapa Insecticide ULV	1812-407	95.0% Malathion/5.0% Inerts	III or IV	Caution	"This pesticide is toxic to fish, aquatic invertebrates, and aquatic life stages of amphibians." ***
Dibrom Concentrate Insecticide	59639-19	87.4% Naled/12.6% Inerts	I	Danger	"This pesticide is toxic to fish, aquatic invertebrates, and wildlife." ***
Formula MU-17	5011-71	20.0% Naled/80.0% Inerts	I	Danger	"MU-17 is also toxic to fish, shrimp, crayfish, crabs and other aquatic Invertebrates." ***
Fyfanon ULV	4787-8	95.0% Malathion/5.0% Inerts	III or IV	Caution	"This product is toxic to fish."
Trumpet EC Insecticide	59639-90	78.0% Naled/ 22.0% Inerts	I	Danger	"This pesticide is toxic to fish, aquatic invertebrates, and wildlife." ***
PYRETHROIDS					
Anvil 2+2 ULV	1021-1687-8329	2.0% Sumithrin and 2.0% PBO, Technical/ 96.0% Inerts	III or IV	Caution	N/A
Anvil 10+10	1021-1688-8329	10% Sumithrin and 10% PBO, Technical/ 80% Inerts (white mineral oil, aromatic hydrocarbons)	III or IV	Caution	N/A
Aqua-Reslin	432-796	20.0% Permethrin and 20.0% PBO, Technical/ 60.0% Inerts (including odorless mineral spirits)	III or IV	Caution	"This pesticide is extremely toxic to fish and aquatic invertebrates." ***
Biomist 1.5+7.5 ULV	8329-40	1.5% Permethrin and 7.5% PBO, Technical/ 91.0% Inerts	III or IV	Caution	"This product is extremely toxic to fish and aquatic invertebrates." ***
Biomist 3+15 ULV	8329-33	3.0% Permethrin and 15.0% PBO, Technical/ 82% Inerts	III or IV	Caution	"This product is extremely toxic to fish and aquatic invertebrates." ***

Table 2-12
Characteristics of Adulticide Products (continued)

Product Name	USEPA Reg. #	% Active Ingredients/ % Inert Ingredients*	Mandatory Labeling (40 CFR Part 156)		
			Toxicity Category**	Human Hazard Warning	Environmental Hazard Statement
PYRETHROIDS					
Mosquito Beater 2-2	4-389	2.0% Permethrin and 2.0% PBO, Technical / 96.0% Inerts (petroleum distillates)	III or IV	Caution	"This product is extremely toxic to fish and aquatic invertebrates." ***
Flit 10 EC	4816-688-8329	10% Permethrin/90.0% Other ingredients (petroleum distillates)	II	Warning	"This product is highly toxic to fish." ***
Mosquito Beater 4-4	4-390	4.0% Permethrin and 4.0% PBO Technical/ 92.0% Inerts (petroleum distillate)	III or IV	Caution	"This product is extremely toxic to fish and aquatic invertebrates." ***
Permethrin 57% OS	8329-44	57.0% Permethrin/ 43.0% Inerts	III or IV	Caution	"This product is extremely toxic to fish and other aquatic organisms." ***
Scourge Insecticide with SBP-1382/PBO 4%+12% MF Formula II	432-716	4.14%Resmethrin and 12.42% PBO Technical/ 83.44 Inerts	III or IV	Caution	"This pesticide is highly toxic to fish."
Scourge Insecticide with SBP-1382/PBO 18%+54% MF Formula II	432-667	18.0%Resmethrin and 54.0% PBO Technical/ 28.0% Inerts (including aromatic petroleum solvent)	III or IV	Caution	"This pesticide is highly toxic to fish."

* PBO=Piperonyl Butoxide, which is neither an active ingredient nor an inert ingredient but a synergist.

** Category I represents the highest toxicity and IV represents the lowest toxicity.

*** "This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds." Or " This product is highly toxic to bees."

N/A – Not Available

Sumithrin (CAS # 026002-80-2)

Sumithrin (d-phenothrin) is a synthetic pyrethroid and a general-use insecticide that has been in use for 30 years. Sumithrin is used against many adult mosquito species and is used as an insecticide and miticide in commercial, industrial and institutional non-food areas. Sumithrin is also used in homes and gardens and greenhouses, and in pet quarters and on pets.

Piperonyl Butoxide (PBO)

As discussed above, the pyrethroid products contain PBO, a synergist, in addition to their active and inert ingredients. A synergist is a chemical that enhances the effectiveness of another chemical. Synergists are added to the pyrethroid products in order to slow down or prevent the metabolism of pyrethroids, thereby enabling a smaller amount of pyrethroids to have the same pesticidal effect. In some cases, PBO can function as an active ingredient.

Inert Ingredients

In addition to active ingredients including PBO, adulticide products contain "inert" or "other" ingredients. These are simply defined as ingredients with no pesticidal activity. In other words, inert ingredients are present in pesticide formulations mainly as a vehicle or dispersant for the active ingredient, and not necessarily for their insecticidal properties; however, these ingredients can and sometimes do possess toxicological properties. As described above, registrants of pesticide products are not required to publicly disclose detailed information on the inert ingredients in their products unless they pose a hazard to public health or the environment. Only the total percentage by weight of all inert ingredients must be disclosed on the product label. In an effort to obtain information on inert ingredients, NYCDOH formally submitted Federal FOIA (Freedom of Information Act) and State FOIL (Freedom of Information Law) requests to USEPA, NYSDEC, and NYSDOH. In order for these agencies to release such confidential data, the individual registrants must grant approval for the release of their proprietory information. In addition to the FOIA/FOIL requests, NYCDOH met with representatives of the pesticide industry, in an attempt to reach an acceptable agreement on both receiving and disclosing inert information. Ultimately, after several attempts, NYCDOH was unable to obtain all inert information for the purposes of this EIS.

3.A FRAMEWORK OF THE ANALYSIS

INTRODUCTION

The impact issues of concern for the *Mosquito-Borne Disease Control Program* are those associated with application of adulticides to reduce the potential for mosquito-borne disease. The potential for impacts to occur would depend on which adulticide is applied, where it is applied, how it is applied, the meteorological conditions under which it is applied, and what exposure scenarios for individuals and biota (other living organisms in an area) are created by the application. Once these parameters are defined and projected, it is then possible to develop methodologies for assessing the risk and consequences of exposure to adulticides. An overview of the framework of analysis for the various impact assessments is discussed below and shown in Figure 3.A-1.

EXAMINATION OF ADULTICIDES

Product Classification and Ingredients

There are typically two primary constituents found in adulticide products: the "active" ingredient, and "inert" ingredients. Since the "active" ingredient in an adulticide product is the chemical component in the adulticide that is intended to target and eradicate the adult mosquito, it is of primary significance for the public health and natural resources impact assessments. The potential adverse effects of these active ingredients on the public health and natural resources are extensively analyzed. "Inert" ingredients, defined as any ingredient in the product that is not intended to affect a target pest (an ingredient with no pesticidal effect), are generally added as solvents and/or to aid in the dispersion of the product. It should be noted that the analyses in this EIS evaluate the potential impacts from all products registered with New York State that would likely be used on a community-scale basis, and consider each of these products to be equally effective in reducing mosquito populations.

NYS REGISTERED ADULTICIDE PRODUCTS TO BE ANALYZED

There are seventeen adulticides (11 pyrethroid and 6 organophosphate products) registered in New York State that can be used for community-scale use. This EIS will consider the potential impacts of

only the products that are registered at this time, with their current formulations. Changes in product formulations are likely over time, and the NYCDOH may evaluate new formulations in the future. Although all 17 adulticides could potentially be used by NYCDOH as part of the Proposed Action, five products, each containing one of the active ingredients of concern, were chosen for presentation of detailed technical analysis to assess potential adverse impacts from application. These products, which are indicative of the products that are most likely to be used by NYCDOH as part of the Proposed Action contain a combination of the highest content of active ingredient and/or PBO, and the least amounts of inerts. The exception to this was the choice of Fyfanon ULV (which contains a slightly lower percentage of the active ingredient) as this was the product used by the City in 1999. These products are:

- Fyfanon ULV Ultra Low Volume Concentrate Insecticide (active ingredient: malathion)
- Dibrom Concentrate Insecticide (active ingredient: naled)
- Permethrin 57% OS (active ingredient: permethrin)
- Scourge Insecticide with SBP-1382/PBO18%+54% MF Formula II (active ingredients: resmethrin/PBO)
- Anvil 10+10 (active ingredients: sumithrin/PBO)

As mentioned above, for the purposes of the EIS, the synergist PBO will be considered as equivalent to an active ingredient. Therefore, within the five products listed above, further references to the six "active ingredients" refer to malathion, naled, permethrin, resmethrin, sumithrin and PBO.

Current manufacturer product labels were obtained from NYSDEC for all the above-mentioned adulticides registered in New York State that can be used for community-scale use. Beyond identifying the ingredients in each product, the labels provide information on how the adulticide is to be used and limitations on how the products may be applied.

MODELING RESULTS

USEPA's ISCST3 model was employed to estimate conservatively the maximum predicted concentrations and deposition levels (the amount of material deposited on a surface) of the adulticide products being analyzed. The modeling was based on the assumption that the area to be treated was within the 300 ft swath adjacent to the source of application.

For airborne concentration and deposition level estimates, receptors (i.e., location of potential public access) were evaluated at distances away from the source at: 25 ft to 600 ft (at 25 ft intervals), 750 ft, 1,000 ft and 2,000 ft. Airborne concentrations were estimated at pedestrian-level receptors (6 ft above grade), as well as receptors at 12 ft, 15 ft, 25 ft, 50 ft, 75 ft, and 100 ft above grade. Deposition levels were estimated at ground level receptors (0 ft above grade), as well on surfaces at 12 ft above grade.

The results indicated much higher deposition levels when simulated at truck-level source heights (12ft above grade), as opposed to aerial level source heights. Therefore, to provide conservative estimates of likely spraying activities in New York City, the ground application results of the modeling were used as inputs to the public health, and natural resources risk analyses.

Table 3.A-5 presents the results of the maximum predicted airborne concentrations from ground applications of the active ingredients for each of the five products being analyzed. The modeling runs that produced the highest predicted concentrations were used as inputs to the public health and natural resources risk assessments. The results represent a "peak" maximum concentration value at a distance of 25ft from the source.

Table 3.A-5
Active Ingredient Concentration Modeling Results

Adulticide	Active Ingredient	1-hour Average Concentration (µg/m3)* Peak Value at 25 ft Receptor Distance	
		Maximum Value	@ 6ft Receptor Height
Organophosphates			
Fyfanon ULV Concentrate Insecticide	Malathion (95%)	57.1	48.0
Dibrom Concentrate Insecticide	Naled (87.4%)	18.4	15.5
Pyrethroids			
Permethrin 57% OS	Permethrin (57%)	22.1	18.6
Scourge Insecticide with SBP-1382/ PBO 18% + 54% MF Formula II	Resmethrin (18%)	7.38	6.21
	PBO (54%)	22.1	18.6
Anvil 10+10	Sumithrin (10%)	3.80	3.19
	PBO (10%)	3.80	3.19

* Micrograms of active ingredient per cubic meter of air.
Source: ISCST3 modeling runs with maximum allowable label application rates

The results are given for the concentration estimated at a pedestrian level height (6 ft above grade) and the maximum from all other modeled receptor heights.

Table 3.A-6 presents the results of the maximum predicted deposition levels from ground applications of the active ingredients for each of the five products being analyzed. The modeling assumes that the first pass of a spray truck or helicopter occurs adjacent to a 300-foot swath treatment area, and all subsequent passes occur parallel to, and upwind from the first pass, at intervals of 300 feet. The results represent a "peak" maximum deposition value at a 25ft distance from the first pass of the source and an average deposition value within the 300ft swath adjacent to the first pass of the source (which incorporates multiple passes of the truck every 300ft upwind of the first pass).

The results are given for the deposition levels estimated at ground level receptors (0 ft above grade) and surfaces at receptors located 12 ft above grade.

The results of the analysis showed that from multi-pass ground application, most of the larger size droplets in the adulticide application would be deposited within the first 300 feet from the source. While the finer droplet sizes can be transported by the prevailing wind and drift beyond the 300-foot application area, the maximum airborne concentrations were determined for locations immediately adjacent to the point of application from trucks. Therefore, the potential airborne and deposition levels of adulticides at further downwind distances were computed to be significantly less than those included in the technical impact assessment analyses.

These results were used as part of the inputs for the technical analyses in this EIS.

Table 3.A-6
Active Ingredient Level Modeling Results

Adulticide	Active Ingredient	Average Deposition Level (mg/m^2)			
		Average Within 300 ft		Peak Value at 25 ft Receptor Distance	
		Ground Level	Surface at 12 ft Height	Ground Level	Surface at 12 ft Height
Organophosphates					
Fyfanon ULV Concentrate Insecticide	Malathion (95%)	5.01	6.91	25.0	36.1
Dibrom Concentrate Insecticide	Naled (87.4%)	1.62	2.23	8.09	11.7
Pyrethroids					
Permethrin 57% OS	Permethrin (57%)	1.94	2.68	9.71	14.0
Scourge Insecticide with SBP-1382/ PBO 18% + 54% MF Formula II	Resmethrin (18%)	0.65	0.89	3.24	4.67
	PBO (54%)	1.94	2.68	9.71	14.0
Anvil 10+10	Sumithrin (10%)	0.33	0.46	1.67	2.40
	PBO (10%)	0.33	0.46	1.67	2.40

* Milligrams of active ingredient per square meter of surface.

REPRESENTATIVE AREAS FOR EIS ANALYSIS

With the range of environment types in mind, and since it would be impossible to gauge the impacts of adulticide spraying on every neighborhood in New York City, seven representative geographic areas of the City have been selected for site-specific study (See Figure 3.A-3). These areas are representative for projecting potential Citywide impacts from the Proposed Action. As shown in Table 3.A-7, the Representative Areas include the full range of environment types to be found in New York City, some likely mosquito breeding grounds, and locations of vulnerable human populations and threatened and endangered wildlife species. These are:

- College Point
- Jamaica Bay and Environs/Paerdegat Basin Area
- Edgemere/Far Rockaway
- Soundview/Hunts Point
- Jerome Park/Van Cortlandt Park South
- Manhattan's Upper East Side
- Lemon Creek/Wolfe's Pond

These Representative Areas are shown in Figures 3.A-4 through 3.A-11.

Table 3.A-7
Representative Areas and Environment Types

Environment Types	College Point	Jamaica Bay/Paer-degat Basin	Edgemere/ Far Rockaway	Soundview/ Hunts Point	Jerome Park/Van Cortlandt Park South	Man. Upper East Side	Lemon Creek/ Wolfe's Pond
Residential							
Low-rise	X	X	X	X	X		X
Mid-rise	X	X	X	X	X	X	
High-rise			X	X	X	X	
Parks/Open Areas							
Public open space	X	X	X	X	X	X	X
Paved open areas	X	X	X	X	X	X	
Unpaved open areas (including residential front and rear yards)	X	X	X	X	X		X
Marinas/Waterfront Recreation (i.e., beach, boating)	X	X	X	X			X
Natural Resources							
Upland forest		X			X	X	X
Upland field	X	X	X		X	X	X
Tidal wetland	X	X	X	X			X
Freshwater wetland	X	X				X	X
Water Supply		X	X		X		
Sensitive water bodies (including estuaries, rivers, basins)	X	X	X	X		X	X
Community Facilities/ Institutional Uses							
Schools	X	X	X	X	X	X	X
Hospitals			X				X
Elder care centers	X	X	X		X	X	
Commercial							
Retail	X	X	X	X	X	X	X
Outdoor Dining	X	X			X	X	
Open markets				X		X	
Large Vacant Parcels		X	X	X			
Industrial/Transportation							
Municipal facilities (including transfer stations, WPCP, depots)	X	X		X	X		
Manufacturing/warehouse	X	X		X			
Rail/Transit system			X	X	X	X	X
Major Arterials/Highways	X	X		X	X	X	X

Source: Allee King Rosen & Fleming, Inc., October 2000.

EXPOSURE SCENARIOS

An exposure scenario describes the way by which a person or biota can potentially be exposed to adulticides as a result of spraying. Exposure Scenarios are defined by the potential "populations" (public health) and "receptors" (natural resources) which may be exposed—and the "pathways" by which they may be exposed. The various populations and receptors, and exposure pathways included in the analyses for public health and natural resources are outlined below.

Public Health

The various human populations that can potentially be exposed to adulticiding activities are identified below. To account for the variability in human populations (i.e., differences in age, or levels of 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:

Human Populations

Residents:

- Young Child (0-6 years)
- Older Child, Adolescent and Adult (older than 6 years)

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)

Exposures to developing fetuses, pregnant women, the elderly, and those with chronic illnesses are also accounted for within the populations listed above, and will be discussed in further detail in the Public Health Analysis. Exposures to people in subways would be less than those projected for residents and workers.

General Exposure Scenarios Related to Public Health

During spraying application, adulticide formulations will be dispersed in air, and may settle and leave a residue directly on an individual's skin, due to dispersion and spray drift. Adulticide residues may also settle on non-targeted outdoor surfaces (such as lawns, gardens, and swimming areas) and surfaces within homes (through open windows or ventilation systems). There is also the potential for

insecticides to enter public water supply systems. For the above populations, at least one of the following scenarios for each pathway will be considered in the public health analysis.

Inhalation

Listed below and illustrated in Figure 3.A-12 are the various exposure scenarios related to inhalation of adulticides through direct and indirect exposure.

- Spray drift while spraying
- Re-suspended outdoor soil/dust
- Vaporized from domestic water supplies while showering/bathing if water is contaminated.

Dermal (Skin) Contact

Listed below and illustrated in Figure 3.A-13 are the various exposure scenarios related to dermal contact through direct and indirect exposure.

- Drift while spraying
- Contaminated soil
- Swimming/wading
- Showering/bathing
- Contaminated surfaces
- Contaminated laundry

Ingestion

Listed below and illustrated in Figure 3.A-14 are the various exposure scenarios related to ingestion through direct and indirect exposure.

- Incidental, from deposition on skin/hands while spraying
- Incidental, via dermal transfer from contaminated surfaces to hands
- Contaminated soil
- Incidental, from water while swimming/wading
- Drinking water
- Fruits and vegetables
- Fish and shellfish

Natural Resources

The various wildlife that can be potentially exposed to adulticiding activities are identified below. In this study, these species are called "receptors."

Receptors

Terrestrial (Land) Receptors

- Mammals
- Birds

- Insects
- Sensitive Plants

Aquatic Receptors

- Fish
- Crustaceans (Daphnids)
- Aquatic Insect Larvae
- Mollusks
- Algae
- Amphibians

General Exposure Scenarios Related to Natural Resources

The primary source of exposure to terrestrial systems is direct contact to the spray. Mammals, birds, insects, and other non-target organisms may experience direct exposure through inhalation of the spray drift or through direct bodily contact with the adulticide from deposition, which may then be ingested during grooming or preening. The drift from application can also transport adulticides to ponds, streams, and wetlands, where aquatic organisms may potentially be exposed through direct contact with the water. Figure 3.A-15 illustrates the various exposure scenarios related to the direct exposure of adulticides to terrestrial and aquatic receptors.

Secondary sources of adulticide exposure include those that occur through the terrestrial and aquatic-based food chains. For example, spray that falls on grasses, seeds, and insects may be consumed by birds and mammals. Fish-eating birds and mammals are also potentially exposed through the aquatic-based food chain from either fish that have been exposed through direct exposure to the spray or through runoff from precipitation (i.e., rainfall that washes away deposited adulticides to water bodies) events that may follow an adulticide application. The various scenarios related to exposure through secondary sources are illustrated in Figure 3.A-16.

3.B LAND USE, COMMUNITY FACILITIES, PUBLIC POLICY, AND ZONING

The application of adulticides under the Proposed Action is not expected to directly change the use of land within the seven representative study areas, or the City, as a whole. However, it may cause some spaces normally open to public use to be closed immediately before, during and shortly after application. This would be considered a direct short-term impact to that use.

The use of outdoor areas would be diminished during the times of adulticide application and, most likely, in the hours immediately before and after application occurs. It should be noted that, while the adulticide application would result in the temporary closure of parks and some other public spaces during the application period, the effects of the application on land use are not expected be significantly greater than if the Proposed Action were not implemented (No Action condition). That is, the public's reduced use of outdoor areas as a result of high incidences of adult-mosquito-borne viruses would be similar to, and may exceed, the public's reduced use of outdoor spaces as a result of adulticide application. Overall, while the adulticide application may temporarily affect the use of land, no significant adverse land use impacts are expected as a result of the proposed adulticiding activities.

Residents, workers, and visitors in New York City may be exposed to adulticides through a variety of pathways. The environment in which an application occurs is one key determinant of exposure. The land use analysis focuses on environment types with the highest potential sensitivity to adulticiding activities: residential uses, community facilities and institutional uses, commercial uses, parks and publicly-accessible open spaces, and selected industrial uses. Within these categories, the most sensitive uses are associated with a high level of outdoor activity—parks and open spaces, outdoor sitting areas, open-air restaurants and markets, and other popular neighborhood gathering places.

3.C PUBLIC HEALTH

INTRODUCTION

The primary purpose of the proposed *Mosquito-Borne Disease Control Program* is to protect the public from outbreaks of mosquito-borne diseases, such as West Nile virus encephalitis. One means of adult mosquito population control is pesticide spraying, which in itself may pose a risk to public health. The public health analysis examines the anticipated benefits to public health from adult mosquito control (reduction in the potential for an outbreak of a mosquito-borne disease such as encephalitis) versus the potential for a percentage of the City's population to come into contact with a pesticide used for mosquito control and to react adversely to it following both short-term and long-term exposures.

An assessment was made of current and future baseline conditions in the project's Representative Areas without the proposed *Adult Mosquito Control Program* (as per the CEQR process). This analysis also addresses the potential for adverse public health impacts from the Proposed Action, including the potential risk to the city's residents and visitors from the adulticides proposed for the program. Included is a comparison of the potential for illness, both mild and serious, with or without the proposed *Mosquito-Borne Disease Control Program*.

The EIS process requires agencies to disclose the potential significant adverse environmental impacts, if any, of a proposed program and examine, to an appropriate extent, how these impacts can be avoided or minimized. As part of this effort the lead agency must disclose whether significant adverse public health impacts may occur as a result of the project. *Public health* refers to the health of a population, rather than an individual. Issues to be considered when determining whether an impact would be considered "significant" to public health include the likelihood of occurrence, the time frame, seriousness of the potential health effect, duration, the number of people affected, and reversibility of potential impacts.

The process of weighing risks and benefits of pesticide application is complex. It entails determining the likelihood and dose of the exposure and then reviewing the potential impacts on the general population and on sensitive members of the public, such as children and people with chronic illness. The public health impact of not spraying (i.e., the likelihood that some members of the public may become seriously ill or die as a result of a mosquito-borne illness) is evaluated as well.

In order to help make this determination, this EIS will combine information from a review of scientific literature, the Risk Assessment, Epidemiologic and Attributable Risk Analyses, as well as summary information from reports received by the New York City Poison Control Registry and NYSDOH Statewide Pesticide Poisoning Registry in determining whether potential adverse public health impacts would be significant.

CURRENT AND FUTURE CONDITIONS WITHOUT THE PROPOSED ACTION

Public Health Characteristics of the 1999 West Nile Virus Outbreak

When the outbreak of West Nile virus in the New York City metropolitan area came to light in the summer of 1999, a total of 59 hospitalized cases were detected. Seven of these people died. Of the 59 hospitalized patients, approximately 62 percent were age 65 and older. At the time, it was not known how many others had been exposed to the virus and how many of those people had become sick. To more fully understand the public health impact of the epidemic, clinical spectrum of illness and the possible risk factors for infection, a household-based survey of blood serum samples ("seroprevalence survey") was conducted through the cooperative efforts of NYCDOH and CDC (the Public Health Service, the U.S. Department of Health and Human Services, and the National Center for Infectious Diseases).

The locale chosen for the survey was a three-square-mile area of northern Queens, considered to be the epicenter of the outbreak, where 9 of the 59 hospitalized patients in 1999 lived. Within that area, cluster sampling was used to select a representative sample of households. All individuals 5 years and older were eligible. Serum samples were tested for antibodies to the West Nile virus. Of the 677 participants from 459 families, 19 (2.6 percent) were found to be positive for recent exposure to West Nile virus. (Statistical analysis found the 95 percent confidence interval—an interval within which a value would be expected to lie 95 percent of the time– ranging from 1.2 percent to 4.1 percent.) Seropositive individuals were more likely than seronegative individuals (29 percent vs. 11 percent) to report a recent illness with fever ("febrile" illness). All 6 of the seropositive persons reporting a febrile illness reported muscle ache, 5 had headaches, 5 had fatigue, and 4 had joint pain. Three had consulted a doctor. Based on a population over five years old of 47,368 residents within the three square-mile area (from the U.S. Census, 1990), an estimated 219 febrile illnesses from infection with West Nile virus occurred in the study area, resulting in an estimated 123 outpatient visits. This compares with 9 cases originally diagnosed clinically in the area during the outbreak. Some 993 persons had asymptomatic West Nile virus infections. Extrapolating from the 59 hospitalized cases throughout the region, the study estimates that approximately 7,900 people in the region may have been infected, with 1,400 contracting mild febrile illnesses and 6,500 showing no symptoms.

As suspected, people who spent much time outdoors at dusk or dawn—peak biting periods for the *Cx. pipiens* and several other types of mosquitoes—and people who never used DEET-containing insect repellant showed the highest risk of infection. The presence of dead birds in a neighborhood also signaled a higher risk of West Nile infection.

Potential Characteristics of Future Outbreaks without the Proposed Action

The 1999 outbreak, which occurred during the summer, was determined to be associated with West Nile virus. Beginning in early September, the City implemented a substantial emergency program to control the outbreak through public education efforts and the spraying of areas suspected to harbor infected mosquitoes.

Therefore, although the August-September 1999 outbreak is the closest experience New York City has to an uncontrolled, "no action" condition (i.e., without adulticiding), it was not entirely without intervention. (Adulticide spraying did occur in September to control adult mosquitoes.) However, the No Action condition includes larviciding as part of the *Routine Program*. Since Citywide larviciding actions were not undertaken in 1999 (the first year of the outbreak), data on the benefits of larviciding could not be included in this assessment of projected illness without the Proposed Action. Therefore, the projection of illnesses and hospitalizations in the Representative Areas may in fact be an

overestimation. However, since the scenarios for the project's Representative Areas rely on empirical data that are recent and come from New York City, it is possible, given the experience in Romania, Russia, and Israel, where the outbreaks were not identified and dealt with as quickly as in New York City, that the illustrative scenarios could underestimate the extent and severity of the public health consequences associated with no larviciding and no adulticiding. Also, since it is probable that West Nile virus is here to stay (may become endemic to the area) and considering the virulence of the recent outbreaks in other developed nations, future outbreaks here could be considerably more severe than the one the City experienced in 1999, should preventive actions and the Proposed Action not be undertaken.

In order to estimate morbidity in each potentially affected community, the rates of infection, febrile illness, and hospitalization that were estimated from the October 1999 seroprevalence survey, and the rates of clinically diagnosed encephalitis in the summer of 1999 were applied to the populations in each Representative Area (See Table 3.C-3). These estimated rates were: infections in 2.6 percent of the population, febrile illness (fever) in 0.46 percent of the population (about 18 percent of those infected) and hospitalization in 0.02 percent of the population (about 0.8 percent of those infected). It should be noted that applying these infection, illness, and hospitalization rates to the Representative Areas assumes outbreak conditions in each area. That is, these rates assume that, without an adult mosquito control program, an outbreak similar to that which occurred in examined northern Queens in 1999 could potentially occur in any part of the City, as represented by the seven Representative Areas examined here.

Citywide figures assume an outbreak would occur across the entire City, which would be unlikely but not impossible without a mosquito control program. As discussed above, these are assumptions of infection rates that could be expected should outbreaks similar to that of 1999 occur in each Representative Area. The actual rates are likely to vary based on the demographic and land use characteristics for each study area. That is, in an area like Lemon Creek/Wolfe's Pond, in Staten Island, it is possible that infection rates may be higher than in an area like the Upper East Side of Manhattan, since an outbreak might be worse due to the greater number of mosquitoes in this part of Staten Island. Since there are too many factors to arrive at a reliable quantification of the difference in potential infection rates for each study area, the same infection rates are assumed for each study area. Additional information on each of the study areas can be found in Chapter 3.B, "Land Use, Community Facilities, Public Policy, and Zoning."

In the absence of an adult mosquito control program, Representative Areas are projected to experience anywhere from 88 infections/mosquito season (in Lemon Creek/Wolfe's Pond) to almost 1,900 infections/mosquito season (in the Upper East Side) in the future. For every 100 people infected, about 18 would be projected to come down with a febrile illness, and approximately one of those would be sick enough to require hospitalization. Judging by the rate of death among diagnosed, hospitalized cases in 1999 (7 of 59), 4 of the 33 people in these representative study areas projected to be hospitalized could die as a result of a mosquito borne disease outbreak in the future without an adult mosquito control program.

PROBABLE IMPACTS OF THE PROPOSED ACTION

To examine the potential for adverse public health impacts of the Proposed Action, the public health analysis employed three techniques: Literature Review, Risk Assessment, and Epidemiologic and Attributable Risk Analyses. The following sections provide the methodology used, and then present the results and conclusions for each of these analyses.

Table 3.C-3
Projected* West Nile Infections: Future Without an Adult Mosquito Control Program**

Representative Area	1990 Total Population	Projected Infections	Febrile Illnesses	Doctors' Visits	Hospitalizations
College Point	22,367	581	103	58	4
Paerdegat Basin	35,317	918	163	91	6
Edgemere/Far Rockaway	14,813	385	68	38	2
Hunts Point/Soundview	28,080	730	130	73	4
Jerome Park	35,217	915	163	91	6
Upper East Side	73,011	1,897	338	189	11
Lemon Creek/Wolfe's Pond	3,382	88	16	9	0
Representative Area Totals	212,187	5,514	981	549	33
New York City	7,422,564	192,898	34,317	19,218	1,140

Notes: *Any given summer if there is an outbreak.
** Since data on benefits of larviciding could not be included, projections may be an overestimation. However, given the experience in other countries, the projections may be an underestimation.

Sources: Population—U.S. Census of Population, 1990; Infections, febrile illnesses, and doctors' visits—submitted for publication by Farzad Mostashari et al., "Epidemic West Nile Encephalitis, New York, 1999: Results of a Household-Based Seroprevalence Survey"; Hospitalizations—submitted for publication by Denis Nash et al., 2000, "Outbreak of West Nile Virus Infection, New York City Area, 1999."

Methods of Analysis

Literature Review

A literature search was conducted to assess potential human and animal effects of pesticide exposure based on peer-reviewed published articles and government documents. This literature search was performed in three major databases using the DIALOG information retrieval service. Two databases—MedLine and ToxLine—from the National Library of Medicine (NLM) were included in the DIALOG searches. NLM contains abstracts for thousands of scientific and medical publications. MedLine covers the medical and public health journals (including, among others, Journal of the American Medical Association, the New England Journal of Medicine, the CDC's Morbidity and Mortality Weekly Report, Environmental Health Perspectives, Environmental Research, Journal of Occupational and Environmental Health, and the American Journal of Epidemiology). ToxLine surveys broader toxicology literature, including some conference proceedings and international toxicology guidance documents. These two databases offer extensive and complete toxicological and health information on chemicals, including the six active ingredients evaluated in the EIS. Additionally, the DIALOG query searched the National Technical Information Service (NTIS) database, which contains Federal government documents and USEPA reports. This DIALOG query was performed for all known adulticide active ingredients (malathion, naled, permethrin, resmethrin, sumithrin, and PBO), and the general categories of inert ingredients found in the adulticide products considered in this EIS, and all possible health effects they might cause.

Insecticides are developed to kill insects, and they may 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 irritatation;
- 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.

The DIALOG literature search included parameters to search all human epidemiological and case study data resulting from exposure to one or more of the insecticides. Studies of toxicity in whole animals and isolated tissues under experimental conditions were also included in the literature search parameters. From the full list of search results, only those documents relevant to single compound exposures at common daily or occupational levels were reviewed. This excluded some studies (e.g., those examining exposure to multiple adulticides) that were unable to clearly implicate toxicity from the active ingredients under the exposure scenarios expected after spraying. The literature search also almost exclusively covered publications in English, although abstracts that had been translated into English from certain publications in other languages were also 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. More than 500 scientific articles were reviewed regarding the potential health effects associated with exposure to the active ingredients in the adulticides. From these reviewed articles, only those documents relevant to single compound exposures at common daily or occupational levels were reviewed. Approximately 150 documents are actively cited in this literature review.

In addition, articles and studies were gathered, to the extent possible, on the experience of communities in Europe, the Middle East, and Africa with outbreaks of the West Nile virus.

Risk Assessment

The objective of the public health risk assessment in this EIS is to determine whether the application of adulticides to control the transmission of mosquito-borne pathogens in New York City may pose a significant human health risk. In a public health risk assessment, there are four steps:

- 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. Using air dispersion and deposition models for the active ingredients in the adulticide products, estimates of the resultant deposition and airborne concentrations and the potential for drift of insecticides from the proposed operations were developed. This information serves as the foundation for the public health risk assessment studies and the evaluation of alternatives.

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.

Exposure Analysis

In this second step of the public health risk assessment, the following guidance documents are used to develop a range of exposure parameters for the different groups of people identified in each geographical area:

- *Risk Assessment Guidance for Superfund, Human Health Evaluation Manual* (USEPA, 1989a). This contains the general exposure equations used to estimate the amount of adulticide taken in by people (see detailed discussion in the Calculation of Exposures section). This document, published in 1989, remains the standard guidance document for risk assessment for human health. As more information and refinements to risk assessment methodology have become available, supplemental guidance documents have been issued, including the following, which were also used in this risk assessment:
- *Calculating the Concentration Term, Supplemental Guidance* (USEPA, 1992a). This supplemental guidance was developed specifically to provide a standardized approach to calculate chemical concentrations to which people may be exposed in various media, (e.g., soil, water, food, etc.).
- *Exposure Factors Handbook: Volume 1. General Factors; Volume 2. Food Ingestion Factors; Volume 3. Activity Factors* (USEPA, 1997a,b,c). This three-volume set is a compilation of exposure data under a variety of exposure conditions. This information was used to determine the range of potential exposures for people in each of the geographical areas.
- *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment, Interim Guidance* (USEPA, 1999a). This guidance was developed specifically for skin exposures and provides recommended values to estimate skin exposures.

These documents are used because they represent the most current and complete knowledge for performing human health risk assessments. Most states that have available risk assessment guidance derive their information from these USEPA documents. Limitations associated with risk assessment guidance are addressed in the Alternative Assumptions Analysis section.

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 (College Point, Jamaica

Bay/Paedergat Basin, Edgemere/Far Rockaway, Hunts Point/Soundview, Jerome Park/Van Cortlandt Park South, Manhattan Upper East Side, Lemon Creek/Wolfe's Pond Park), several human populations which can potentially be exposed to adulticide spraying activities are identified for this EIS. To account for the variability in human populations (e.g., 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 subpopulations as listed in Section 3.A of this Executive Summary.

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.

USEPA (1991) recommended age ranges were used to characterize exposure for residents. Exposure duration is assumed to be 30 years, from ages 0 to 30 years, per USEPA (1991) guidance. Carcinogenic and noncarcinogenic risks were calculated separately for two age groups: 0 though 6 years (6 year period) and 7 through 30 (24 year period). USEPA considers children to be the most sensitive age group (i.e., greatest hand-to-mouth behavior, low body weight), therefore, exposures are expected to be higher in this age group than for older children or adults.

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.

A quantitative assessment of workers applying the adulticides was not performed in this EIS. These aduliticides must be applied by appropriately certified and trained applicators and these workers fall under the guidelines outlined by the Occupational Safety and Health Administration (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 within 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 breakdown rate.

The pathways by which people, animals, and plants can be exposed to an adulticide depend on when it is applied, and what medium (e.g. water, air, soil, surface) is affected. The airborne concentrations in people’s breathing zones may be affected by the spraying and also by the disturbance of “fugitive dust” containing the adulticides. (“Fugitive dust” would include, for example, dust generated by wind blowing, people walking on unpaved paths, gardening, or construction.) The public health risk analyses are based on the dispersion modeled results from ground-level (truck) spraying, as these resulted in the most conservative values (maximum amounts) for both concentrations in air and surface deposition levels.

Acute (short-term) exposure pathways are defined in this EIS as those pathways with exposure durations of less than one day. Acute exposure pathways include those associated with exposure to adulticides immediately after application (i.e., inhalation of drift, skin contact with drift while spraying, and ingestion from hands of drift deposited on hands). Subchronic exposure pathways are defined as those pathways with exposure durations of half a year. This assumes the selected adulticide ingredient would be used during only one spray season (during the active season for mosquitoes, from May to October). Chronic (long-term) exposure pathways are defined as those pathways with exposure durations to a maximum of 30 years. This assumes the selected adulticide ingredient would be used for mosquito control during each spray season for the entire 30 years. The selection of a 30–year exposure duration is based on two assumptions: 1) The typical upper-bound estimate for people living at the same location is approximately 30 years (USEPA, 1997c); and 2) different adulticides tend to be used over time as insects may develop resistance to the adulticides' active ingredients.

For subchronic and chronic exposures, the exposure concentrations used in the modeling 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 60-day spraying period. Based on the assumption for the frequency of application an adulticide could potentially be sprayed on days 1, 4, 14, 17, 27, 30, 40, 43, 53, and 56 (10 spray events in one season) in any given area. 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 exposure concentrations 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 exposure concentrations expected within 300 feet of the spraying locations are used for assessing subchronic and chronic exposures.

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.

Before defining these terms, it should be noted that risks of harm are evaluated differently for cancer than for all other illnesses. For health effects other than cancer, scientists attempt to determine the maximum dose that is considered safe if a person is exposed on a daily basis. For cancer, however, risk is evaluated according to *probability*; specifically, the increased probability that an individual will, during his or her lifetime, develop cancer following a specific exposure to a chemical.

First, the toxicity criteria for health effects other than cancer will be discussed. 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 (Barnes and Dourson, 1988; Dourson et al., 1989; USEPA, 1989a). "Chemical-specific" refers to the fact that RfDs and RfCs are unique to a particular chemical; each

chemical has its own RfD and RfC. The difference between a reference "dose" and a reference "concentration" is that a reference "dose" refers to what individuals take into their bodies (e.g., through ingestion or through the skin), measured as a ratio of chemical ingested or absorbed to an individual's body weight per day, whereas a reference "concentration'' is the amount of a chemical that an individual is exposed to through breathing. Acute (short-term) and subchronic RfDs and RfCs are similar to chronic (long-term) RfDs or RfCs, except that the acute and subchronic RfDs and RfCs represent a daily exposure that is not likely to cause adverse health effects for exposures occurring during a shorter period of time (subchronic exposure) or a single day (acute exposure). Because adequate human data are not available for the adulticide ingredients evaluated in this public health risk assessment, toxicity values are all based on animal studies.

The second type of criteria is the cancer slope factor (CSF) and unit risk (UR). Like the CSF, the UR is the increased probability that an individual will develop cancer following a specific exposure to a chemical. This increased probability is in addition to everyone's probability of developing cancer from everyday exposures to a multitude of chemicals. The CSF parallels the RfD (it is used for ingestion exposures), while the UR parallels the RfC (it refers to concentrations in the air). It should be noted that not all chemicals can cause cancer.

The toxicity criteria used in this EIS were provided by the following sources:

- USEPA's Hazard Identification Assessment Review Committee (HIARC) documents,
- USEPA's Integrated Risk Information System (IRIS) files,
- USEPA's Office of Pesticide Programs (OPP), and
- USEPA's "Tox 1-Liners," which contain summaries of toxicology studies submitted to the Health Effects Division of USEPA's OPP.

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 exposures 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.
- 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 (MOE), 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).
- Alternative Assumptions Analysis, which discusses the implications of the results of this public health risk assessment associated with the selection of exposure assumptions.

Evaluation of Non-Cancer Health Risks

Non-carcinogenic health risks are characterized as the increased likelihood (as opposed to incremental probability) that an individual will suffer adverse health effects (excluding cancer) as a result of chemical exposure. USEPA and other agencies have developed estimates of acceptable daily doses (the reference dose or concentration) over an exposure duration. USEPA defines the chronic reference dose RfD as an estimate of a daily exposure level for the human population, including sensitive individuals (e.g., the elderly, developing fetuses, pregnant women, the chronically ill), that is likely not to create an appreciable risk of deleterious effects during a lifetime (USEPA, 1989).

To evaluate non-cancer risks, the ratio of the average daily dose associated with a particular exposure pathway to the acceptable daily dose is calculated. This ratio, referred to as a hazard quotient (HQ) indicates whether a specific exposure to an adulticide's active ingredient (e.g., inhalation of malathion in air by a child resident) is likely to result in adverse health effects.

If the ratio is equal to or less than one, no adverse health effects are expected from a daily exposure to the active ingredient (i.e., the exposure level is less than the amount to which people, including sensitive individuals, can be exposed on a daily basis without experiencing adverse non-cancer health effects).

An individual may be exposed to an adulticide through a variety of exposure pathways, as described earlier under the "Exposure Analysis" section. For each individual, the hazard quotients (HQs) for all the relevant pathways for a specific active ingredient are then summed to derive a hazard index (HI). This HI 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.

Evaluation of Cancer Health Risks

Cancer risks for permethrin and malathion are evaluated using a CSF. Although there is some evidence that resmethrin, sumithrin, and PBO may be carcinogenic, CSFs have not been derived for these compounds by USEPA. Therefore we evaluate cancer risks for resmethrin, sumithrin, and PBO using an MOE analysis. Naled is not considered to be carcinogenic in humans. Therefore, cancer risks for naled are not evaluated.

Evaluating Cancer Risk Using a CSF. 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 (USEPA, 1992). 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 0.0001 (i.e., one in ten thousand).

Evaluating Cancer Risk Using an MOE Analysis. The MOE is the ratio of the Point of Departure, divided by the actual exposure dose in humans above background. The Point of Departure is a dose, usually determined through animal studies, associated with a negligible increase in cancer. The MOE based on the Point of Departure can also be referred to as the calculated MOE. Because the actual human exposure dose is in the denominator of the ratio, lower exposure doses yield higher calculated MOEs. Higher calculated MOEs suggest greater certainty that the exposure dose is sufficiently

below the point of departure that the cancer risk is negligible. For some chemicals, such as PBO, USEPA has recommended "advisory" MOEs or "comparison" MOEs. Comparison MOEs take into account a number of factors that influence the certainty associated with the safety of the point of departure, and represent an MOE that provides sufficient certainty that cancer risks will be negligible at the actual human exposure dose. In general, higher comparison MOE values suggest there is greater uncertainty associated with the safety of the point of departure. As long as a calculated MOE is greater than a comparison MOE, there is little cause for concern regarding cancer. Likewise, a calculated MOE that is within the same order of magnitude of a comparison MOE also indicates that the exposure dose is sufficiently below the point of departure that cancer risks should be negligible. However a calculated MOE significantly below the comparison MOE would suggest a potential for increased cancer risks.

The magnitude of an acceptable MOE depends on the data that were used for identifying a threshold dose, as well as relevant information regarding variability within animal species (e.g., variability within human sensitivity) and between species (e.g., variability between laboratory test animals and humans). An acceptable comparison MOE can range anywhere from 1 to 10,000. For some chemicals, there is sufficient understanding of the biological processes leading to cancer, as well as differences between animals and humans regarding these processes, to know with a fair amount of certainty that any dose at or below the threshold dose would not be associated with an increased cancer risk. Therefore, for these chemicals, under USEPA guidance, an acceptable MOE is 1.0. For other chemicals, either the biological processes leading to cancer, and/or the differences between animals and humans regarding these processes, are not fully understood. Therefore, USEPA recommends that actual exposures for these chemicals be well below the threshold dose, resulting in an MOE greater than 1.0, to provide an added margin of safety.

The magnitude of the comparison MOE depends on the data and information available for defining the threshold dose, as well as the degree of uncertainty regarding these data and information. If the data are sufficient, and there is little uncertainty regarding these data, then the comparison MOE will be low (e.g., 10). On the other hand, if there are significant gaps in the database or information regarding a chemical, and/or some uncertainty regarding these data and information, then the comparison MOE will be higher (e.g., 100 or more). For example, if the RfD for non-cancer hazards is also considered to be a threshold dose for cancer, USEPA generally recommends a comparison MOE of 10.

Although there is some evidence that resmethrin, sumithrin, and PBO may be carcinogenic, CSFs have not been derived for these compounds by USEPA. Cancer risks for resmethrin, sumithrin, and PBO are therefore evaluated using a MOE analysis.

PBO is classified by the International Agency for Research on Cancer as a Group 3 carcinogen, indicating it is not classifiable as to its carcinogenic potential in humans, due to inadequate evidence in either animals or humans (IARC, 1983) USEPA has however, classified PBO as Group C (a possible human carcinogen). For PBO, USEPA specifically recommends using the RfD as the threshold dose, with a comparison MOE of 10. USEPA has not quantified carcinogenic potential of sumithrin or resmethin, nor has it recommended a threshold dose and comparison MOE. There is sufficient evidence indicating that sumithrin is not genotoxic (harmful to genetic material), and that sumithrin causes cancer only at very high doses (far greater than one would experience following spraying). Therefore, using sumithrin's RfD as the threshold dose, a comparison MOE of 10 should be adequately protective. Although there is no evidence in the literature that resmethrin is genotoxic, carcinogenic effects are observed at lower doses in animal studies. Therefore, resmethrin's RfD was

used as the threshold dose, with a comparison MOE of 100. 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 comparison MOE could indicate a potential health risk.

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. 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. Because children are the most sensitive population group, RBCs for children were calculated under the residential scenario. Therefore, RBCs for children are lower, and thus more conservative, than RBCs for other population groups.

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. Overall, despite the inherent uncertainties, the risk estimates calculated in this assessment are conservative, and are likely to over-predict actual risks.

Epidemiologic and Attributable Risk Analyses

Epidemiologic Analysis

To examine the possible impact of adulticiding on asthma exacerbations in New York City, NYCDOH collaborated with NYSDOH and CDC to develop analytic plans that would use existing data on emergency department/urgent care visits and hospitalizations and that would make best use of data available on adulticiding. The analyses were designed to determine whether the relative change in rates of asthma (i.e. emergency department/urgent care visits and hospitalizations for asthma) before (Pre-period) and after (Post-period) adulticiding occurred in 1999 was different from the change in the same time period in prior years, when no adulticiding occurred. While these analyses have been designed to reduce some of the potential biases or confounding factors in the data, there are inherent limitations of the exposure and outcome data.

The analyses examined whether asthma emergency department/urgent care visits or hospitalizations were increased after spraying in 1999 for West Nile virus. Since the entire City was sprayed in many areas at least twice during the month of September, there were no non-exposed areas to use as a control to compare the sprayed areas with non-sprayed areas in 1999. Thus, data from the same months in past years were used as comparisons. Therefore, since adulticiding began in September, when hospital admissions and emergency department visits for asthma normally increase, we compared the increase between August (the unexposed period) and September (the exposed period) in 1999 to the increase in asthma events between August and September in prior years. The relative increase was examined by comparing September to August for each year in the monthly hospitalization analyses. Both the "weekly hospitalization analyses" and the "weekly emergency department/urgent care analyses" for each year compared each of the five weeks post-Labor Day (to control for school openings) with the average weekly events in August for each year. For the hospitalization data, while information on month and year was available, information on the day of

the event was available only for 1995-1999 and thus the weekly analyses could only be performed for these years. For the monthly analyses, where day of week was not necessary for determining the month of the event, data from 1989-1999 were used.

The comparisons were made by calculating a rate ratio (RR) that compared September to August respiratory events in each year. An RR of 1 suggests that there was no increase between August and September. An RR of greater than 1 suggests that the number of respiratory events was greater in September than in August. An RR of less than 1 would indicate that the number of respiratory events was less in September than in August. Since asthma events increase in September compared to August, RRs are generally greater than 1 for each year. Thus, the objective was to determine how the RR in 1999 compared with previous years.

These analyses assume that any differences in hospital admission policies and practices would have a similar affect on August and September emergency department/urgent care visits and hospital admissions within a year.

Attributable Risk Analysis

In addition to the epidemiologic analysis, an alternative approach was used to estimate the number of asthma hospitalizations that could potentially be attributed to adulticide application. This analysis made use of epidemiologic studies that report associations between changes in ambient air particulate concentrations and asthmatic events. In this approach, the number of asthma exacerbations that would be expected from the transient increment in airborne particulate concentrations caused by the spraying events are predicted.

Specifically, increases in asthma hospitalizations were predicted from increased concentrations of total particulate matter less than 10 microns in diameter (PM_{10}) resulting from both active and inert ingredients. The attributable risk calculation relied on conservative estimates (i.e., a worst case scenario) of population exposure to incremental PM_{10} levels from the applied adulticides. That is, the assumptions that were made tended to overestimate the possible asthma impact of spraying events.

CONCLUSIONS

The public health analyses indicate that the potential for illness, both mild and serious, without a program to control the adult mosquito population would be greater than the risk of adverse reaction to the chemical ingredients in the adulticides proposed for the *Mosquito-Borne Disease Control Program*. The conclusions from each public health analysis (Literature Review, Risk Assessment and Epidemiologic and Attributable Risk Analyses) are discussed below.

Literature Review

Although there is some evidence that certain inerts can cause skin irritation in humans, skin irritation would more likely occur only after direct contact on the skin with liquid forms rather than from exposure associated with inert droplets and mists. Because all of the active adulticide ingredients have been linked to skin and eye irritation in humans, unnecessary exposure to workers and residents should be minimized to the greatest extent possible during the spraying intervals to reduce the potential for skin and eye effects.

From the data available, only the two organophosphate compounds, malathion and naled, appear to produce gastrointestinal symptoms. These effects occurred when people were exposed to levels far higher than would be expected from spraying in New York City. No reports were found linking either the pyrethroids, the synergist, or the inerts to these ailments.

Based on this review of the available literature, the application of adulticides is not expected to significantly increase the occurrence of asthma attacks or other respiratory health effects due to the very low exposure concentrations associated with mosquito control. However, the available data are limited and there may exist in New York City a susceptible sub-population who might have a pre-existing sensitization due to prior exposures due to occupation (e.g., exterminators) or hobbies (e.g., gardening).

Allergic reactions beyond irritation reactions have not been found to be commonly caused by any of the active ingredients reviewed in this report. The immune system enhancing or reducing health effects of the active ingredients are still poorly understood at this time. Malathion's mixed effects on the immune system are thought to be caused by a common contaminant in malathion mixtures, generally associated with storage of malathion. Similarly, the data on permethrin and resmethrin are also inconclusive as to what effects, if any, they have on the immune system and illness rates in humans or animals. At this time it is not possible to conclude with certainty what impact, if any, the adulticides might have on the immune system.

There are conflicting reports found in the peer-reviewed scientific literature on the possible links between the active ingredients and the synergist and Multiple Chemical Sensitivity (MCS). One report provides a list of substances which may contain certain ingredients that are possibly in the adulticide products that can be suspected of causing the onset of MCS. Although people with MCS often do report a link between their illness and exposure to pesticides, to date no scientific studies in the available literature reviewed have definitively linked pesticide exposure with MCS. The controversy surrounding the cause of MCS may encourage researchers to explore more aggressively the causal links between the onset of the illness or development of symptoms and environmental factors. However, without a scientific consensus on the processes that create susceptibility to MCS, it is not possible to evaluate the role that adulticides or their chemical constituents might play in MCS reactions.

The current peer-reviewed scientific literature indicates that exposure to some of the active ingredients of adulticides, as well as some of the inerts, is associated with neurological effects in humans and animals. The symptoms and durations of these effects vary widely, and may be caused by multiple biological mechanisms. It is noteworthy that malathion breakdown products more toxic than malathion itself can be formed after the preparation has been stored for a long period of time. Many of these studies demonstrate effects elicited under short-term, high-level exposure to the active and inert ingredients in adulticides. Examples of exposures that are more representative of the spraying of adulticides in New York City indicate that neurological effects would be either mild or completely absent in both humans and animals. For instance, some studies report that long-term, low-level exposure to organophosphates is generally thought to result in short-term effects on cognitive function, and neurological components of the eye. However, other studies of humans exposed to malathion are either complicated by simultaneous exposure to other chemicals, or present contradictory evidence of nervous-system effects in humans. The literature suggests that other adulticide ingredients such as permethrin are regarded as having negligible health effects at low levels of exposure, while available data on resmethrin and sumithrin show no neurological damage even at high levels of exposure.

In general, the causes of learning disabilities ranging from autism to mild retardation are not well understood, and possible environmental causes of these developmental disorders are uncertain at this time. Many researchers and environmental health specialists agree that more neurologic and developmental toxicity research is needed on environmental contaminants, including pesticides. For

example, age-dependent sensitivity and developmental periods of susceptibility need to be examined in pesticide developmental toxicity evaluations at all stages of development (Bruckner, 2000; Claudio *et al*., 1999). However, based on published studies, it is unlikely that pesticide exposures could be deemed responsible for either causing or exacerbating these conditions.

In general, the identity and mechanisms of endocrine disruptors are not well understood at this time. Many researchers and environmental health specialists agree that more laboratory screening and testing are needed on potential endocrine disruptors, including pesticides, both individually and in mixtures. However, based on the current evidence, of the compounds of interest, only malathion is a suspected endocrine disruptor with serious reproductive effects. It is uncertain whether two of the three pyrethroids considered in this EIS, permethrin and sumithrin, may also have endocrine disruptive effects. In all cases, it is unlikely that insecticide exposure due to spraying would be high enough to be deemed responsible for causing endocrine disruptive effects.

The scientific evidence suggests that for the adulticide active ingredients evaluated in this EIS, developmental effects are not likely to occur in the absence of other health effects in parents. By contrast, reproductive effects were found in animal tests for every adulticide, but the doses needed to produce those adverse reproductive effects varied widely. With regard to reproductive toxicity effects in animal tests, the lowest doses causing adverse effects were the following: malathion (1 mg/kg and reduced conception rates), sumithrin (300 mg/kg and birth defects), and resmethrin (500 mg/kg and developmental toxicity in a 3-generation study). The literature suggests that the safest compounds in animal tests based on the doses needed for adverse effects were permethrin (greater than 2,500 mg/kg) and PBO (1,000 mg/kg). With very limited data available for naled it is not possible to determine safe doses of naled at this time.

Each of the doses described in the animal studies summarized here correspond to human exposure levels much greater than those anticipated following the spraying of adulticides for mosquito control. For example, the anticipated exposure to malathion ranges from 0.000013 mg/kg to 0.244 mg/kg. Therefore, no reproductive adverse health effects are expected at the environmental doses following spraying. This expectation is confirmed by the human evidence citing a lack of reproductive harm in people in areas treated with adulticides for mosquito control. For malathion and permethrin, the limited human data from past pest-control efforts suggest that no adverse reproductive or developmental effects should be expected from the anticipated exposure levels of these ingredients.

Numerous environmental health protection agencies at international, Federal, and State levels regulate compounds based on their known or suspected ability to cause cancer. Of the adulticide compounds considered in this EIS, only malathion and permethrin have been studied enough to be adequately classified by the IARC or the USEPA. Both of these are listed as suggestive or possible carcinogens. As seen in the review of the literature for all the adulticide compounds, the other three active ingredients (naled, resmethrin, and sumithrin) have very limited data and no final decision has been made regarding their carcinogenic potential. Similarly, the synergist PBO has too little data for classification as a carcinogen or non-carcinogen.

Risk Assessment

According to the public health Risk Assessment, none of the evaluated human populations (i.e., child and adult residents, workers, homeless people, school children and teachers, park visitors, and community gardeners) have HIs (ratios of exposures over non-cancer health criteria) exceeding a value of 1.0 for all active ingredients evaluated in this assessment under average or reasonable maximum exposures. Thus, non-cancer adverse health effects are not expected. Although the HIs are still below a value of 1.0 for naled, potential exposures to naled resulted in the highest ratios;

whereas, potential exposures to sumithrin resulted in the lowest ratios for all active ingredients evaluated in this assessment. Because of the various safety factors incorporated in 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 the active ingredients are not expected for these individuals.

Carcinogenic risks characterized for the human populations evaluated above are within or below the USEPA-determined acceptable target risk range of less than one in one million to one in ten thousand. The highest cancer risk of roughly one in 200,000 estimated in this assessment is for residents (child and adult combined) under reasonable maximum exposures to permethrin. This value represents the added probability of getting cancer above the background cancer risk typically experienced by all individuals in the course of daily life. 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 (or one chance in 2.3) in men and 38.3 percent (or one chance in 2.6) in women. Although still within the acceptable target risk range, the highest risks for all human populations evaluated in this assessment are associated with exposures to permethrin. Cancer risks associated with exposures to malathion are approximately 10 to 100 times lower than risks associated with permethrin.

Although toxicity criteria for cancer are not available for resmethrin, sumithrin, and PBO, there is some limited evidence that these active ingredients may be carcinogenic. An MOE analysis was performed for resmethrin, sumithrin, and PBO for the resident children (considered to be the most sensitive human evaluated in this risk assessment), and for resident adults. In this analysis, to ensure adequate protection for human health, a calculated MOE should be greater than the comparison MOE. The comparison MOE was selected as an additional safety factor to ensure adequate protection for human health. The calculated MOEs (i.e., reference dose divided by exposure dose) for resmethrin and sumithrin are greater than the comparison MOEs for these two chemicals, which indicates that potential exposures to these two chemicals by resident children is low enough not to be of concern. The calculated MOE for PBO (at the highest concentration found in pyrethroid products—54 percent), is slightly lower than the comparison MOE. Although this would imply that potential exposures to PBO present in an adulticide product may not be low enough to ensure adequate protection for human health, it is not considered a significant adverse public health impact due to the likelihood of overestimation in the calculations.

Finally, results from the RBC approach to evaluate acute exposures (e.g., inhalation of drift, skin contact with drift while spraying, and ingestion of drift deposited on hands) by resident children 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. However, the maximum-modeled air concentrations for malathion and naled are greater than the calculated RBCs, which would imply that immediate health effects could potentially result from malathion and naled exposures. However, given the conservative assumptions used in this calculation, exposures are likely overestimated. Therefore, considering the conservative assumptions, and the short-term (acute) nature of the exposure, exposures to malathion and naled would not constitute a significant adverse public health impact.

Uncertainties in this public health risk assessment exist in numerous areas, including derivation of toxicity values, and estimation of potential exposures to adulticides by human populations. However, where uncertainties exist, conservative inputs or approaches were used so that potential risks would be overestimated.

Epidemiologic and Attributable Risk Analyses

Epidemiologic Analysis

No conclusions about the potential relationship between adulticide use and asthma exacerbations can be made from the results of the epidemiologic analyses. For the most part, the data indicated that, overall, the use of adulticides did not appear to appreciably increase asthma hospital admissions or emergency department/urgent care visits in 1999 at the population level relative to prior years. However, in some subgroups or boroughs increases were found. An important criterion in epidemiology is whether results are consistent across groups and in different studies. Additionally, the more analyses that are performed, the more likely it is to identify a positive finding. While our analyses have revealed some findings that may be suggestive of higher asthma rates after spraying, these findings were not consistently found and must, therefore, be interpreted with caution. However, because analyses at the zip code level were not possible for 1999 or at the individual level (i.e., exposed individuals only), only gross population changes can be detected. As a result, this analysis cannot rule out the possibility that use of adulticides precipitated an increase in asthma or respiratory exacerbations in subgroups of New York City's population.

The epidemiologic analyses are an attempt at investigating the effects of adulticides on asthma exacerbations. 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 epidemiological research utilizing more sensitive exposure and outcome as well as measures of potential confounders need to be developed.

Attributable Risk Analysis

The results of the attributable risk calculation show that the maximum effect predicted for children would be about 1 asthma hospitalization per 1,000 baseline annual asthma hospitalizations. The maximum effect predicted for adults would be about 0.27 hospitalizations per 1,000 baseline annual asthma hospitalizations.

For 1999, the total number of baseline asthma hospitalizations for children aged 0-14 in the Representative Areas was 938. Hence, a maximum effect of about 1 of the asthma hospitalizations per year would be predicted as a result of the spraying. For 1999, the total number of baseline asthma hospitalizations for people ages 15 and over in the Representative Areas was 1,299. Hence a maximum effect of about 1 asthma hospitalization every 3 years would be predicted as a result of the spraying.

For the entire City, the number of 1999 asthma hospitalizations was 12,782 for children ages 0-14, and 18,794 for adults ages 15 and over. Hence, if the entire City was subjected to 10 applications of adulticides and 100% of the population was directly exposed to the adulticide spraying, the above methodology would predict a maximum annual impact of 12 hospitalizations for children ages 0-14 and 5 hospitalizations for adults ages 15 and over that would occur as a result of the spraying.

Overall Conclusions

For this EIS, potential public health impacts in New York City from the implementation of the *Mosquito-Borne Disease Control Program* were evaluated using three major approaches: Scientific Literature Review; Risk Assessment; and Epidemiologic and Attributable Risk Analyses. 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 providing 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 above 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 upon 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 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 whom have pre-existing sensitizations. Also, 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 suggested 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 of 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 exacerbations. 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.

The potential impacts from spraying adulticides should be compared with the potential public health impacts if adulticide spraying were not conducted. The West Nile virus outbreaks in New York City in both 1999 and 2000 demonstrated that West Nile virus infection can result in serious illnesses,

including encephalitis and meningitis, and deaths. In other countries that had not experienced large outbreaks of the virus, recent outbreaks have been surprisingly severe. Since 1996, there have been significant West Nile virus outbreaks in southern Russia (40 deaths, approximately 1000 diagnosed cases) and Romania (17 deaths, approximately 500 diagnosed cases). Less severe illnesses associated with West Nile virus infection could affect New York City residents, as demonstrated by the results of the serosurveys conducted in Queens and Staten Island. 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.

For PBO, because there is less cancer risk information available, a very conservative USEPA cancer model was used. This model employs a comparison number to which a calculated cancer risk number is compared. The calculated risk number should equal or exceed the comparison number. The NYCDOH EIS Risk Assessment defined long-term exposure as 10 spray events in a 2-month period, occurring every year over 30 years to the maximum concentration of PBO found in any of the pyrethroid products evaluated. The calculated cancer risk number (8) was very close to the comparison cancer risk number of 10. Given the very conservative exposure assumptions made and the conservative modeling used, the cancer risk from PBO is in all likelihood overpredicted.

Among a minority of persons in the general population, exposure to the adulticides evaluated in this EIS could result in minor, short-term, self-limiting symptoms including eye and nose irritation and/or respiratory symptoms from the Proposed Action. Long-term non-cancer health effects were determined to be unlikely, and the risk associated with long-term exposure to PBO is considered to be negligible from the Proposed Action.

The likelihood of symptom occurrence would be increased for people who are directly exposed, such as those individuals who are accidentally directly sprayed. As with other exposures that could potentially have adverse effects, reducing exposure is of prime importance. Every precaution would be taken to prevent such occurrences. NYCDOH would make every reasonable effort to keep the public informed with respect to the schedule for applying the pesticides, so that sensitive persons and the general public can take appropriate precautions to prevent exposure. Spraying would generally be applied in the late evening hours, and announcements would be made preceding the vehicles as a warning to people who may be in the immediate area.

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-Borne Disease Control Program* and that any effects would likely be less than those of West Nile virus.

The analysis relies on the universe of information available (such as the literature review, the results of the risk assessment and the epidemiologic and attributable risk analyses), and the precautions that would be undertaken by NYCDOH. NYCDOH is aware that the experiencing of symptoms by particular individuals even if for a relatively short period of time, may be considered "significant" to those affected persons. However, in determining the significance of the potential adverse impact of the Proposed Action on public health, NYCDOH has determined that the potential adverse effects to the population from applying pesticides would not be considered significant when they are outweighed by the potential risk to the public health if the Proposed Action were not taken.

NYCDOH may need to use adulticides to prevent serious illness and deaths from West Nile virus 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.

3.D NATURAL RESOURCES

As part of this study, the robust variety of natural resources throughout the City and within the seven Representative Areas were identified. The potential adverse effects of the proposed *Mosquito-Borne Disease Control Program* on these resources were assessed using the approach and methodology described below.

The methodology used for the ecological risk assessment described more fully in the preceding sections consisted of the following steps.

- Literature Review—The existing literature was reviewed to provide information on the physical and chemical characteristics of the adulticides, assess the toxicity to natural resource species, and characterize the fate and effects of the adulticides in the environment.
- Screening Level (Tier I) Risk Assessment—The objective of the screening-level risk assessment is to focus the overall ecological risk assessment process by eliminating from consideration those possibilities that do not have the potential for resulting in adverse effects to plants or animals.
- The detailed (Tier II) Risk Assessment—The Tier I analysis identified those stressors and pathways which would require additional investigation prior to making decisions regarding potential ecological risk. The purpose of the focused or detailed (Tier II) risk assessment is to evaluate these areas needing further assessment under more realistic conditions and assumptions to better reflect the City's current conditions, such as those found within the respresentative areas.
- Empirical Studies—Results of field studies conducted throughout the country that evaluated effects of adulticide spraying on natural resources were compiled and evaluated.

A weight of evidence approach that incorporated the results of empirical studies and conclusions drawn from the risk assessments was then used to assess the potential effects of the active ingredients to the City's natural resources.

In the future without the proposed *Mosquito-Borne Disease Control Program* (i.e., the No Action Condition), control measures including the application of larvicides in potential mosquito breeding grounds such as storm drains/catch basins, sewage treatment plants, and stagnant water, and the use of larvivorous fish in waters that are contained and do not have uncontrolled discharges to natural aquatic systems, such as sewage treatment plants, will occur.

The City assessed the potential environmental effects of the following larvicides in the Negative Declaration:

- Methoprene (insect growth regulator)—Altosid XR Briquets, Altosid Briquets, Altosid Liquid Larvicide, and Altosid XR-G Granules. Methoprene targets mosquito larvae in aquatic habitats but may also be toxic to other invertebrates. Methoprene mimics the action of an insect growth regulation hormone. When applied as an insecticide, it interferes with the normal maturation process that enables the pupa to develop into an adult. Because of this potential to affect non-target organisms, methoprene will only be applied to systems (sewers and catch basins) that do not discharge to surface waters or ground water.

Methoprene is practically non-toxic to humans and other mammals. It is slightly toxic to birds, and slightly to moderately toxic to fish, and very highly toxic to some species of freshwater, estuarine, and marine invertebrates. Methoprene degrades rapidly in water and soil through microbial action and photolysis, and does not leach to ground water. When applied at the rates recommended for mosquito control, methoprene has been found to affect aquatic stages of other dipterans, but population reductions have between temporary. Methoprene has been found to affect amphibians at levels higher than applied for mosquito control.

- *Bacillus sphaericus* (*Bs*) (naturally occurring soil bacterium)—Vectolex CG and Vectolex WDG. These bacterial products target mosquito larvae. Bs produces a toxin when its spores and crystals are ingested by the mosquito larvae. Symptoms (tremors and sluggishness) appear within 30 minutes to 1 hour, with mortality usually 48 hours after exposure. *Cx.* species appear to be the mosquitoes most susceptible to Bs, and Bs has been found to exhibit longer periods of larvicidal activity than Bti against certain species of mosquitoes, especially in habitats with high organic content. In fact, viable infective spores have been retrieved several months after introduction into larval habitats, suggesting possible recycling of this bacterium once applied for mosquito control. Bs has not been found to be toxic to non-target invertebrates, other animals, and humans.
- *Bacillus thuringiensis isrealensis* (*Bti*) (naturally occurring soil bacterium)—Vectobac. This bacterium targets mosquito, blackfly, and midge larvae. Bti produces a toxin, in the form of crystalline bodies, during spore formation. The crystals are released from the spores in the insect's gut after being consumed by the larvae. Mortality can occur within a few hours to a few weeks. The Bti toxin only binds to receptor cells present in the guts of insects, and has been found to be practically non-toxic to humans and animals.

These larvicides are registered with USEPA and NYSDEC for use against mosquitoes, and were selected by the City because of their anticipated effectiveness, and minimal impacts to the environment. The Negative Declaration, found at www.ci.nyc.ny.us/html/doh.html/epi/wnvnd.html, provides a detailed description of these larvicides. They will be applied to catch basins, sewage treatment (if larvivorous fish appear to be ineffective), freshwater ponds and lakes, and wetlands as necessary, as described below. All larvicides will be applied by hand and/or backpack. Wheeled or tracked vehicles will not be used to treat vegetated areas of tidal or freshwater wetlands. Truck or aerial application will be used where access for hand or backpack spraying is limited.

ASSESSMENT APPROACH

The ecological risk assessment was organized in two tiers. Tier I is the *screening-level* assessment. The purpose of the screening-level assessment is to focus the overall ecological risk assessment process by eliminating from consideration those possibilities that do not have the potential for resulting in adverse effects to plants or animals from the Proposed Action. Therefore, if by applying worst-case conservative assumptions to the screening-level (Tier I) analysis, the results show no potential adverse impacts for a particular stressor (e.g. active ingredient) or pathway, then those stressors or pathways can be eliminated from further assessment. If the Tier I assessment does identify a potential adverse effect for a particular stressor or pathway, then a *detailed* second tier (Tier II), or focused assessment, would be performed to evaluate these effects under less conservative conditions and assumptions. The Tier II risk assessment results are then used in conjunction with empirical results from monitoring and other field investigations to evaluate the potential for risks to the natural resources within each of the Representative Areas.

Screening Level (Tier I) Risk Assessment

The Tier I assessment often uses worst-case, conservative assumptions for determining exposure concentrations and environmental conditions, many of which far exceed those likely to occur. As a result, the Tier I assessment is likely to greatly overestimate the true impact to natural resources, but is useful in screening out possibilities that are identified with no potential adverse impact from adulticide applications. The steps followed in conducting the Tier I assessment include:

- Toxicity assessment—this includes a description of the chemical and physical characteristics of the adulticides based on the literature review, how the active ingredient behaves in the natural environment with respect to metabolism, degradation, migration, and volatilization. The toxicity assessment was used to help focus the risk assessment.
- Description of the ecosystem at risk and the potential receptors—using the toxicity assessment, and the description of current conditions of natural resources, the potential receptors to be evaluated in the screening-level risk assessment were identified.
- Development of conceptual models—using the toxicity assessment and the potential receptors identified for evaluation along with the toxicity characterization, conceptual models were developed that identify the active ingredients, exposure pathways, and potential sensitive receptors.
- Exposure characterization—for each of the conceptual models developed for analysis, the worst hypothetical exposure concentration of each active ingredient was calculated for each exposure route identified in the models.
- Ecological effects characterization—toxicological benchmark concentrations are presented for each potential receptor identified for evaluation based on the results of the literature review. These are taken from the results of laboratory toxicity testing of the active ingredients on test organisms for registration or reregistration of the active ingredient. For potential receptors where no toxicological benchmark concentrations are available, surrogate species were identified.
- Risk characterization—to characterize the ecological risks of the adulticides, HQs were used to be able to compare exposure concentrations or doses with the toxicological benchmark concentrations or doses. The HQ is the estimated environmental concentration divided by the toxicological benchmark concentration for a particular test organism. HQ=exposure concentration/benchmark concentration.
- Uncertainty factors—assumptions that affect the results of the risk assessment were identified and discussed along with a description of how they may affect the assessment.

The Tier I analysis used three types of worst-case assumptions:

- The most sensitive biota exposed to the adulticide;
- The highest or maximum exposure concentration of the adulticide expected to occur on land and in surface waters; and
- The highest bioconcentration factor for the adulticides through the aquatic and terrestrial food chain.

The ecological risk assessment evaluates the risk to animals exposed to the active ingredient by calculating a hazard quotient (the estimated exposure concentration divided by the toxicological benchmark). An HQ of less than one suggests little risk to the receptor (e.g., animal) examined. In

calculating the hazard quotient, the toxicological benchmark concentration or dose should be the chronic no observable adverse-effects level (NOAEL). When this benchmark is unavailable, other benchmarks taken from available data are used and an uncertainty factor is calculated. Data that are generally available include results from laboratory studies that most often report the concentration required to kill 50 percent of the test organisms (LC50), or concentrations that can produce other observable adverse effects, such as reduced reproductive ability (Lowest Observed Adverse Effect Level [LOAEL]). Since these concentrations should be considerably higher than those that would result in no observable effects, the uncertainty factors need to be fairly large, and a series of conservative uncertainty factors were incorporated into the analyses.

The analyses also addressed the potential impacts from up to 10 repeat applications over a two-month period. The model assumed that active ingredients were applied by truck at the maximum rates on days 1, 4, 14, 17, 27, 30, 40, 43, 53, and 56.

Exposure Scenarios

The exposure scenarios evaluated for the Tier I screening-level risk assessment each identify a potential source, one or more pathways, and one or more receptors. Five exposure scenarios were evaluated for the Tier I Screening-Level risk assessment:

- Terrestrial Receptors with Direct Exposure;
- Terrestrial Receptors Exposed Through the Terrestrial-Based Food Chain;
- Aquatic Receptors in Ponds Exposed to Drift;
- Aquatic Receptors in Wetlands Exposed to Runoff; and
- Terrestrial Receptors Exposed Through the Aquatic-Based Food Chain.

Terrestrial Habitats

In terrestrial habitats, mosquitoes, other terrestrial insects such as bees, butterflies and moths, other non-target terrestrial organisms and plants will be directly exposed to the spray. Possible direct exposure routes for terrestrial organisms include dermal absorption, inhalation, and consumption of food, water, and soil that have been contaminated by the adulticide. For terrestrial habitats, the adulticides are assumed to be applied to the ground surface at the maximum label rate for each application technique.

Aquatic Habitats

The sources of adulticide in aquatic habitats (ponds, streams, and wetlands) include drift from an application (primary source), and contaminated runoff (secondary source) formed by precipitation (rain) that occurs during or following an adulticide application. Therefore the Tier I assessment evaluated two groups of receptors in aquatic habitats—those exposed to adulticides in drift and by runoff.

Detailed (Tier II) Risk Assessment

The purpose of the Tier II assessment is to examine in greater detail those scenarios identified by the Tier I assessment as having the *possibility* of producing adverse ecological effects on certain natural resource receptors. The Tier II assessment used the same basic conceptual models as the Tier I but attempted to include more realistic assumptions in estimating exposure concentrations, and also used more representative assumptions to describe environmental conditions. Assumptions used in the Tier II risk assessment included incorporating degradation of the adulticides in the environment through

the use of half-life estimates, the change in environmental concentration caused by the partitioning of some adulticides to organic matter in the soil or sediment, decrease in deposition to soil or surface waters with distance from the spray truck, etc. The risks are then characterized using the estimated exposure concentrations, resulting in more representative HQs.

Empirical Studies

The empirical studies or field studies of the fate and effects of the adulticides and active ingredients conducted by other investigators were used to help place the results of the Tier II risk analysis into a more meaningful context. These empirical studies have the advantage of providing "real world" findings from field studies, but the applicability of conclusions is greatly limited by the time, place, and local conditions under which the studies were performed. The results of these studies are not always consistent with results of the risk assessments, which rely largely on laboratory studies and mathematical modeling. A weight of evidence approach that combines both the risk assessment findings and results of empirical studies was therefore used to assess the potential impacts of spraying to the City's natural resources.

A number of field investigations have been performed to assess the effects of the active ingredients on terrestrial and aquatic receptors. The empirical data generated from these studies are extremely useful for impact assessment purposes because they provide a means for evaluating potential risks to terrestrial and aquatic resources under natural conditions. The Tier I and Tier II risk assessments provide a basis for evaluating risk, but studies are performed under controlled laboratory conditions, often for 96-hour periods. Factors such as adulticide breakdown, partitioning of active ingredients onto sediments and other organic and plant material, and dilution can generally not be very accurately represented in the risk assessment models. The empirical field data has the advantage of providing a result that integrates the effects of all of these variables. Some of these field studies provide insights and/or recommendations for mitigating losses to biota. They, however, have the limitation of generally being site specific, with conditions specific to the time and place of study not entirely directly applicable to other situations or locations. For this reason, the results of the empirical studies must be interpreted cautiously, but can be used in conjunction with the Tier I and Tier II findings to help assess potential impacts of the Proposed Action.

SUMMARY OF ECOLOGICAL RISK ASSESSMENT RESULTS

The Tier I ecological risk assessment identified the pathways where it was apparent there would be no likely potential adverse effects to a number of biological receptors. However, this initial assessment also identified the potential for adverse effects for certain biological groups that needed to be addressed on a more detailed level in the Tier II assessment. The biological groups needing additional evaluation included:

- Terrestrial receptors (Insects) with Direct Exposure—Non-target beneficial insects exposed to any of the adulticides.
- Aquatic Receptors in Ponds Exposed to Drift—All groups exposed to all adulticides except (a) mollusks exposed to permethrin and (b) crustaceans exposed to sumithrin.
- Aquatic Receptors in Wetlands Exposed to Runoff—In freshwater, all groups exposed to all adulticides except (a) mollusks exposed to permethrin and (b) crustaceans exposed to sumithrin. In salt water, all groups exposed to all adulticides.

- Receptors Exposed Through Terrestrial-Based Food Chains—There is a slight possibility of adverse effects for grass-eating mammals exposed to permethrin. No other risks to grass eating mammals or other wildlife from adulticides was suggested by the Tier I analysis.
- Receptors Exposed Through Aquatic-Based Food Chain Bioaccumulation—There is a slight possibility of adverse effects for mammals exposed to naled, and possible risk to birds and mammals exposed to permethrin and resmethrin, from consuming fish that have bioconcentrated these adulticides.

The Tier II assessment analyzed these risks within the context of the resources found within the City, further refining the assumptions to represent the existing conditions. The Tier II analysis concluded that there would be no potential significant adverse impacts on organisms exposed to the active ingredients through food chain bioaccumulation. While the Tier II assessment concluded that several of the risks identified in Tier I would not result in adverse effects to the City's natural resources, it also concluded that certain of the pathways identified in Tier II did have the potential to adversely affect certain natural resources within the City.

CONCLUSIONS

The habitats and characteristics of these Representative Areas were utilized to assist in the evaluation of the potential Citywide impacts on natural resources from the Proposed Action. Screening level (Tier 1) and focused (Tier II) ecological risk assessment methods were used to assess the potential adverse impacts on biological receptors from the Proposed Action. In addition, assessments were performed to determine the potential impacts from the operations of the mechanical equipment (such as trucks, all-terrain vehicles and aircraft) on natural resources. The risk assessment calculations were weighted with results from empirical studies, and best professional judgment, to assess the effects and significance of potential impacts of the various active ingredients on resources found in the Representative Areas (and therefore, in the City), in accordance with guidelines in the *CEQR Technical Manual* for determining significance.

Jamaica Bay is sometimes highlighted when the potential impacts due to runoff of adulticides after a rain event are discussed below. This is necessary, not just because the Jamaica Bay environs are included as one of the Representative Areas, but because Jamaica Bay is extensive in size and provides a flourishing environment for wildlife within the City boundaries. Jamaica Bay is also nearly completely enclosed by land with only a narrow inlet to the Atlantic Ocean (between the Rockaway Peninsula and Brooklyn). Approximately 36,700 acres of Brooklyn and Queens, most of which is fully developed, drain to the bay through combined sewer overflows (CSOs) and storm sewers. Given the combination of these circumstances, some of the potential adverse impacts from the Proposed Action could be greater in Jamaica Bay when compared to other aquatic environments in the City. These impacts could occur if significant portions of the drainage area in Brooklyn and Queens were subject to adulticiding actions, and significant rainfall follows within a short period after the applications, resulting in the transport and discharge of adulticides into Jamaica Bay. While Jamaica Bay is a unique ecosystem and the only Critical Environmental Area in New York City, there may be other inlet bays in New York City (e.g., Little Neck Bay in Northern Queens) that exhibit similar characteristics with respect to limited tidal flushing and large storm water discharges. These inlet waterbodies may also experience potential significant adverse impacts on crustaceans like those predicted for Jamaica Bay from the runoff of malathion.

No significant adverse impacts are expected from the application equipment, including trucks or aircraft applying adulticides. No significant adverse impacts are expected from the inerts in the adulticides.

ANALYSES WHICH IDENTIFIED TERRESTRIAL AND AQUATIC ORGANISMS WITH NO POTENTIAL FOR ADVERSE IMPACTS

Based on the results of the Tier I and II analyses, the review of empirical studies, and best professional judgment, several pathways were identified where there would be no potential effects on major groups of terrestrial and aquatic organisms. These pathways and biota are summarized below.

All Active Ingredients

- Birds and mammals by direct inhalation of adulticides.
- Birds by ingestion due to preening of adulticides which could have deposited on their feathers.
- Pets by direct inhalation or drinking water from puddles formed by rainfall after application of adulticides.
- Birds and mammals ingesting adulticides indirectly through the terrestrial-based food chain (including feeding on either grass, seeds, or insects that could have adulticides deposited on them), and predators such as raptors feeding on mammals which have ingested adulticides.
- Birds and mammals ingesting adulticides indirectly through the aquatic food chain (including raptors feeding on fish that may have accumulated active ingredients from runoff into the water column).
- Organisms in the large water bodies of New York Harbor, including the East River, New York Harbor, Hudson River, and Harlem River, with the exception of Jamaica Bay or other inlet bays with limited tidal flushing and large stormwater discharges.

Organophosphates

Malathion

- Fish from runoff, and amphibians via drift in freshwater habitats.

Naled

- Aquatic insect larvae, mollusks, and fish via drift, and crustaceans, brown algae, fish, and mollusks from runoff.

Pyrethroids

Permethrin:

- Aquatic insect larvae, mollusks, and fish, in ponds via drift, and fish and mollusks from runoff.

Resmethrin

- Aquatic organisms in ponds via drift, and crustaceans, fish and mollusks, and species in streams, after consideration of dilution and partitioning to sediments or plant material.

Sumithrin:

- Organisms in ponds, wetlands, and estuarine habitats from drift or runoff.

Piperonyl Butoxide

- Organisms in ponds, wetlands, and estuarine habitats from drift or runoff.

ENDANGERED SPECIES

No significant adverse impact is expected to occur for any endangered species known to presently occur in New York City. The Federally listed piping plover and seabeach amaranth occupy beach areas that would not be subject to spraying. The endangered shortnose sturgeon and sea turtles that occasionally occupy the waters of the New York area are not expected to be adversely impacted by application of the active ingredients. The Arogos skipper is an endangered butterfly that was observed in the northern portion of Staten Island in the serpentine barrens. While no recent sightings have been reported, any individuals of this species that may be present on Staten Island have the potential to be adversely affected by the application of the adulticides evaluated in this document. As part of the proposed project, potential impacts will be reduced by establishing a 300-foot no-spray buffer around the historical location for this butterfly. Potential impacts to species of special concern would be minimized by observance of the City's voluntary no-spray setbacks for wetlands and waterbodies.

GROUPS OF TERRESTRIAL AND AQUATIC ORGANISMS WHICH COULD BE ADVERSELY AFFECTED BY THE PROPOSED ACTION

Based on Tier I and II risk assessment calculations, several groups of terrestrial and aquatic organisms were identified for which potential adverse effects could occur. These organisms would be potentially adversely affected by one of three pathways (via drift and deposition onto freshwater ponds, direct contact with airborne adulticides, or runoff of adulticides from rainfall after application). While there may be some adverse effects and losses of individuals as a result of the Proposed Action, these potential adverse effects are for the most part not considered to be significant adverse impacts. However, there is a potential for application of malathion to result in significant adverse impacts to crustaceans in inlet bays, such as Jamaica Bay. Summarized below are the groups of terrestrial and aquatic organisms (and associated pathways) that could potentially be adversely affected by the Proposed Action. This is followed by a discussion supporting the determination for reaching conclusions regarding significant adverse impacts (presented by pathway) and a separate discussion on potential for significant adverse impacts to Jamaica Bay's natural resources.

All Active Ingredients

- Non-target insects and other terrestrial arthropods from direct contact with airborne adulticides.

Organophosphates

Malathion

- Organisms, including crustaceans and aquatic insect larvae, in ponds, wetlands, and estuarine habitats through deposition of drift or from runoff.

Naled

- Crustaceans in ponds via deposition from drift; aquatic organisms from runoff entering wetlands.

Pyrethroids

Permethrin

- Crustaceans, in ponds via deposition from drift, aquatic organisms from runoff entering wetlands, and crustaceans from runoff entering Jamaica Bay or tidal creeks, such as Lemon Creek.

Resmethrin

- Crustaceans and fish from runoff entering wetlands.

Non-Target Insect and Other Arthropod Terrestrial Wildlife Impacts

While there would be individual losses of insects and other arthropods in the areas near the application of adulticides, especially for night flying arthropods, such diminutions of the insect populations immediately, during, and after the adulticide application are not considered to be signficant adverse impacts. These effects would occur from all active ingredients. Outlined below are the reasons for the determination of no significant adverse impacts.

- The application of adulticides under the Proposed Action would be limited temporally, and would not occur for the full spring, summer, and fall periods. Furthermore, it is highly likely that large areas would be exposed to far fewer than the 10 applications per year assumed in the technical analysis of effects of multiple applications, in this EIS.
- The application of adulticides under the Proposed Action would be limited spatially, and would likely be applied at targeted locations rather than the entire City, for any given application date.
- Potential adverse impacts to non-target organisms, primarily arthropods other than mosquitoes, are likely to be limited to those species that fly or are active during the nighttime hours. Nighttime flying insects would likely be exposed to adulticides in the same way in which mosquitoes would be exposed. However, many insects that fly and are active during the day, such as butterflies and bees (i.e., beneficial pollinators of plants), would likely have less exposure, other than potential residues on plants, to adulticide applications. Therefore, it is not expected that such insects which are active in the daytime would be sprayed directly as would nighttime flying insects (e.g., moths). The majority of insects have several generations per year and produce more than 100 offspring (many produce hundreds) per generation. Many insects that live in leaf litter or underground (e.g., beetles) would likely not experience significant adverse impacts from spraying since they would largely be protected by soil and vegetation.
- Arthropod populations from neighboring unsprayed communities would be likely to repopulate neighboring areas that have experienced short-term losses from the application of adulticides. Although short-term losses of individuals in some arthropod populations in spray zones would be expected to occur, the Proposed Action is not expected to conduct consecutive nightly (i.e., repeated) applications in the same area. Furthermore, many vegetated areas will be buffered from the effects of the adulticides and there are a number of no spray zones identifed throughout the City. Since spraying would not occur year round and potentially only a maximum of ten times over a three month period, it would be expected that within a short time, the sprayed area's populations would rebound to levels that occurred prior to spraying. In most areas and years, far fewer than ten applications per year are expected to occur.

While the loss of non-target insects would not be considered to be a significant adverse impact, the NYCDOH did consider the feasibility of conducting monitoring of non-target insects under the Proposed Action. It was determined that monitoring the potential losses of non-targets could not be feasibly conducted in a cost effective manner for the following reasons:

- Data obtained from any localized monitoring programs could not be extrapolated accurately to indicate non-target insect populations on a city-wide basis.
- There are no quantitative baseline data on the numerous non-target insect or other arthropod species inhabiting the City. Thus, quantitative baseline data for each region of the City would need to be collected prior to spraying.
- As discussed in this EIS, the fluctuating life cycles of individual species further complicate attempts to define pre-adulticiding (baseline) or post-adulticiding conditions throughout the City.
- Due to the sensitivity of such species to other environmental conditions and meteorology (e.g., temperature, rainfall), baseline conditions would need to be established over a long period of time (multi-year) in order to better understand the level of fluctuation in such species (both at a population level and presence in various geographic regions of the City).
- The costs for developing these pre- and post-application characterizations would be significant, and beyond the scope of the Proposed Action.

Given the issues raised above, NYCDOH is not attempting to prepare long term baseline inventories of non-target insects and other arthropods city-wide as part of the Proposed Action. However, NYCDOH will continue to work with other agencies (e.g., NYSDEC, NYCDPR) and stay informed on observations made by local professionals documenting the presence/absence of such species throughout the City, especially endangered species.

Deposition of Drift Into Ponds

Results of the Tier I and Tier II studies indicated that direct drift into ponds would not result in potential adverse impacts on most aquatic organisms. The exceptions were on crustaceans for permethrin and naled, and on crustaceans, insect larvae, and possibly fish for malathion. While the ecological risk assessment studies indicated these possible adverse impacts, results of field studies conducted for assessing effects of permethrin, malathion, and naled, suggest that the actual environmental exposure from direct application for mosquito control may not result in adverse effects in ponds. In the analyses performed for this EIS, the conservative assumptions used in the Tier II risk assessment appear to overestimate the exposure concentration in the environment, and therefore the potential adverse impacts on aquatic organisms exposed to drift in ponds. The risk assessment modeling approach that was employed in this EIS relies on toxicological laboratory studies generally run for 96 hours, and is intended to yield conservative estimates of the potential impacts. The modeling does not account for all potential sources of adulticide degradation (e.g. partitioning on particles in the water column, or binding of pyrethroids with phytoplankton), and such credits are not readily quantifiable. The potential for drift and deposition of adulticides onto ponds would not be expected to have a significant adverse impact on aquatic species in most cases. This finding is supported by the sumithrin and PBO water quality data collected by the City during adulticiding operations undertaken in the year 2000, which generally did not find detectable levels of these active ingredients in ponds following spray events. In cases where losses due to direct deposition could occur (e.g. malathion for fish, crustaceans, and aquatic insects), they are not considered to be

reflective of a significant adverse impact because of the limited temporal and spatial extent of the potential losses.

Potential Runoff into Streams, Wetlands and Other Water Bodies

The results of the risk assessment calculations and the review of reported monitoring results from other areas of the country indicate that there could be individual losses of aquatic organisms in the waterbodies of New York, due to runoff from rainfall after appliction of adulticides.

With respect to runoff, these potential effects would largely occur (at least to some extent) at and near the point of discharge into a waterbody. In general, the greatest to least potential for adverse effects from runoff for the active ingredients would be malathion, naled, permethrin, resmethrin, PBO, and sumithrin. While there may be some losses of individual non-target organisms as a result of the Proposed Action, these potential adverse impacts are not considered to be reflective of a significant adverse impact because of the limited temporal and spatial extent of the potential losses.

- Field and monitoring studies in other portions of the country have demonstrated losses in fish and benthic invertebrates in streams after the application of malathion. These included studies conducted in concert with medfly eradication programs, which would be expected to result in greater impacts on aquatic species as compared to the Proposed Action. The medfly eradication programs did not always include buffer zones from water bodies. In such cases, malathion may have been applied in syrup-like droplets or in aerial applications directly over water. This may have resulted in much higher deposition of malathion concentrations into water bodies, as compared to the Proposed Action, which uses ULV application methods and defined buffer zones in the vicinity of water bodies. In stormwater discharge locations where there is either very low water volume or in immediate areas near the point of discharge, losses of aquatic species can be expected. However, as reported in other studies referenced in this EIS, recovery of benthic communities has been reported to be relatively rapid following cessation of spraying activities.
- Losses of even large numbers of individuals within a population, do not necessarily translate into population declines or result in significant adverse impacts. Most populations have compensatory mechanisms that allow them to remain stable in the face of mortality imposed by natural and non-natural causes. This concept forms the basis of fishery stock management, where some level of commercial and/or recreational fishing can occur without producing reductions in the stock of the fishery.
- The runoff analyses did not account for the effects of partitioning to plant material or sediments (in either fresh or salt water wetlands, or tidal basins) or reductions in toxicity associated with residence time in tidal basins. Because the pyrethroids partition to organic matter and are not highly soluble in water, the organic matter contained within the CSOs and storm sewers should reduce the dissolved concentrations of these adulticides in the water column. Therefore, the calculated levels of pyrethroids, such as permithrin, should be much lower in the water column than as calculated in the risk assessment. Further, many of the receiving waters such as the East River, New York Harbor, Hudson River, and Harlem River are fairly rapidly flushed and have a sufficient volume to significantly reduce the concentration of these active ingredients.
- The Proposed Action would not take place year round, but would likely be limited to applications over a three month window. Furthermore, it is likely that fewer than 10

applications per year would be required in any year at the same locations. The limited application schedule and the fact that not all areas are exposed to the active ingredients, should act to minimize potential effects on natural resources and help maintain stable populations. In cases where losses occur, recovery of aquatic communities from adjacent unaffected areas is expected to be relatively rapid following cessation of adulticide applications, especially for short lived species with multiple generations per year.

- The Proposed Action would not result in any major physical disturbance or permanent loss of habitat. Habitat function or migratory habits of species are unlikely to be affected by the Proposed Action.

POTENTIAL SIGNIFICANT ADVERSE IMPACTS FROM THE PROPOSED ACTION

Based on Tier I and II risk assessment calculations, the potential concentrations of malathion (due to runoff if a storm event occurs after application of malathion over a large land area that drains to Jamaica Bay) could be well above the estimated no effect levels for crustaceans in Jamaica Bay. Field monitoring data of measured malathion levels in waterways after application of the adulticide in other parts of the country support the determination that malathion has the potential to become entrained into storm water and discharged into urban water bodies. The analyses performed in this study assume that a large coverage of land in Brooklyn and Queens would have malathion applied, and rainfall after the application would result in a large runoff of this active ingredient to Jamaica Bay. Given that Jamaica Bay can receive such large discharges of runoff and has limited mixing with the Ocean, the net result is that calculated malathion concentrations in the water can be well above no effect levels for crustaceans. Crustaceans in Jamaica Bay are largely comprised of barnacles, shrimp, crabs, copepods, sand fleas, and other amphipods. Even though the concentrations of malathion would not persist for a long time in the bay, given that the calculated concentrations of malathion would be over a large area with levels well above the calculated no effect level, it was determined that the application of malathion and runoff from rainfall could result in potential significant adverse impacts on crustaceans in Jamaica Bay, particularly in the shallower, near shore areas. Other inlet bays, such as Little Neck Bay, which receive a significant amount of stormwater runoff and have limited tidal flushing, may also have significant impacts predicted for crustaceans. Waterbodies around New York Harbor would have much higher volumes of water available for dilution. Therefore, predicted significant adverse impacts would be limited to Jamaica Bay and other inlet bays with large stormwater runoff and limited tidal mixing.

As part of the Proposed Action, NYCDOH will continue to monitor water bodies before and after any adulticide applications. If malathion is selected in the future, these impacts on Jamaica Bay may be lessened, once completion of the CSO holding tank at Paerdegat Basin is fully constructed (which will reduce the direct discharges into the bay after rainfall). In addition, NYCDOH may elect to apply the active ingredients in smaller droplet sizes (e.g., average mean diameter less than 30 microns), because studies in other parts of the country have shown that smaller droplet sizes substantially reduce the amount of the active ingredient that reaches the ground, and therefore, less would runoff if a rainfall event occurs after the application. Applications by aircraft with smaller droplets would also reduce the potential for runoff into such inlet bays.

3.E WATER SUPPLY

In 1997, the U.S. Geological Survey (USGS), in cooperation with NYSDEC, began a Statewide monitoring program to assess the occurrence of pesticides in groundwater and surface waters of New

York State, including Long Island. As part of this program, water samples were collected at 10 New York City water-supply reservoirs (referred to as the New York City reservoirs network).

Of the 60 active ingredients and active ingredient-metabolites for which samples were analyzed, 16 (27 percent) were detected, 8 of which were herbicides, and 8 of which were herbicide metabolites. No insecticides were detected. Only a few of the compounds detected had a concentration exceeding 0.001 milligram/liter, and no compounds detected in the New York City reservoirs network had concentrations exceeding 0.05 milligrams/liter. None of the compounds detected exceeded any Federal or State water-quality standard. Median total pesticide and metabolite concentration for the New York City reservoirs network was less than 0.00002 milligrams/liter.

New York City Department of Environmental Protection (NYCDEP) also continuously monitors the water quality of the water supply as water enters the distribution system, and regularly tests at sampling points throughout the entire City. NYCDEP conducts analyses for a broad spectrum of microbiological, chemical, and physical measures of water quality. In 1999, NYCDEP collected more than 41,500 in-City samples and performed approximately 594,300 analyses. Principal Organic Contaminants (POCs) are tested as part of this program, and approximately 50 POCs which are included in the monitoring program were below detections limits. This includes POCs, such as toluene and xylene, which help formulate adulticides that could be included in the inerts.

The City remains committed to protecting its water supply sources and distribution. In the future without the proposed *Mosquito-Borne Disease Control Program*, the City expects the water supply to remain of high quality. Pursuant to the adopted Watershed Regulations, NYCDEP reviews all permits submitted to NYSDEC for pesticide applications within the watershed. Should upstate counties apply adulticides to control mosquito-borne pathogens, such actions will have to be limited to label restrictions, and NYCDEP may require additional restrictions. Furthermore, NYCDEP could add monitoring for the presence of adulticides in upstate reservoirs, if warranted in the future.

An analysis of the potential infiltration of adulticides into the surface-water supply was performed. This analysis considered both an exposed, open water-supply source in New York City and sources outside the physical boundaries of New York City. As part of the restrictions on the products and the methods of application that will be employed as part of the Proposed Action, there will be no direct application of adulticides into surface-water supplies within either New York City or counties north of the City. Since the estimates of the concentrations of adulticides serve as an input to the public health risk assessment, a series of conservative assumptions on the fate of the products were assumed. The net effect of these assumptions may overestimate the likely concentrations in the water supply by an order of magnitude (e.g., a factor of 10 times) or more.

The surface-water supply source that could be most affected by adulticide spraying at locations throughout the City is the Jerome Park Reservoir in the Bronx (which is included in the Jerome Park/ Van Cortlandt Park South representative study area). The assessment of the impacts on groundwater supplies addresses the potential deposition of adulticides on the ground (and after rainfall, the migration into the aquifers below southern Queens and Brooklyn, which supply the City's groundwater system) and airborne adulticides (which may enter air strippers and contaminate the water passed through the air stripper). The Edgemere/Far Rockaway and Jamaica Bay and Environs Representative Areas include locations where such groundwater issues may occur.

In addition, since Westchester and Putnam counties may also decide to spray adulticides in the future as part of their control of mosquito-borne viruses, an assessment of the potential cumulative impacts on New York City surface-water supplies was performed following the analysis methods discussed above. This included an assessment of the potential runoff of adulticides into the Croton Watershed

(from actions potentially undertaken by Westchester and Putnam counties) and the potential deposition of adulticides into the Jerome Park Reservoir (which receives water from the Croton Watershed) by NYCDOH sponsored actions. The potential deposition of adulticides into the Hillview Reservoir outside the City's boundaries (which is supplied by the Catskill/Delaware Watersheds much farther north of the City) from adulticiding actions undertaken by Westchester County was also performed. Initial worst-case screening analyses were computed for the public health analyses presented in Chapter 3C, "Public Health", while a second level screening analysis was performed to estimate the potential deposition of adulticides into the Jerome Park and Hillview Reservoirs in order to make more appropriate comparisons of adulticide concentrations in the water supply for comparison to drinking water standards or published health effect levels for drinking water.

Based on the analyses presented in Chapter 3.C, "Public Health", which were used as part of the input to the public health impact assessment and USEPA Health Advisory Levels (HALs) for drinking water recommended by USEPA, the application of the adulticides which could deposit into the "Outside New York City Boundaries" and "Within New York City Boundaries" reservoirs would not result in any significant adverse human health impacts.

3.F WATER QUALITY

An assessment of potential effects to water quality within the representative study areas and the primary surface-water bodies of the City from the application of the mosquito adulticides under the *Mosquito-Borne Disease Control Program* was performed. The water quality of New York Harbor has improved significantly since the 1970s as a result of many measures undertaken by the City that include: eliminating raw dry-weather sewage discharges; reducing illegal discharges; increasing the capture of wet-weather related floatables; and reducing the toxic metals loadings from industrial sources. New York City has implemented a program of aggressive and innovative measures to control the input of pollutants to the major water bodies surrounding the City and continual development and upgrade of the sewage treatment system. The City has constructed new Water Pollution Control Plants (WPCPs), such as Red Hook (1989) and North River (1991), and upgraded existing plants, such as Coney Island (1994) and Owl's Head (1995). The process for upgrading the Newtown Creek plant is underway.

Based on the continuing infrastructure investments that New York City and surrounding counties have been continuing to make, it is expected that water quality within and near New York City will improve due to these ongoing efforts. While the proposed *Mosquito-Borne Disease Control Program* is not targeted to improve regional water quality, there are likely to be changes in water quality for the surface waters in and surrounding New York City without the application of the mosquito adulticides under the *Mosquito-Borne Disease Control Program*.

ORGANOPHOSPHATES

Malathion

Malathion is the only active ingredient in the adulticides considered in the *Mosquito-Borne Disease Control Program* for which a water quality standard (0.1 µg/L for certain classes) has been established. The projected concentrations in surface water from the proposed *Mosquito-Borne Disease Control Program* operations were evaluated as part of the ecological risk assessment presented in the natural resources impact assessment. In addition, extensive research was performed to examine other water quality monitoring studies and data.

The estimated concentration of malathion in a pond (0.0061 mg/L, or 6.1 µg/L), and runoff (0.9533 mg/L or 953.3 µg/L) from truck application developed as part of the Tier I ecological risk assessment are lower than aerial application; however, these conservative predictions still exceeded the standard. The more refined analysis (Tier II) indicated that impacts on water quality from drift and deposition of malathion would be signficantly less.

The HQs calculated for truck application and runoff after applications also indicated potential effects to aquatic organisms. Again, the model appears to overestimate the runoff concentration since it is far larger than the concentrations observed in the referenced monitoring studies in California or Florida where some waters received direct application. The concentrations estimated for the Tier I risk assessment assume the worst case condition of direct application to a pond or the total application rate applied to surface runoff with no degradation. Nevertheless, post-treatment monitoring conducted in California and Florida suggest that the application of malathion has the potential to impact water quality and exceed the State standard in surface water that does not have large flow volumes, particularly in small water bodies receiving stormwater runoff. Therefore, the larger water bodies surrounding the City such as the Hudson River, East River, New York Harbor, and Raritan Bay should have less chance of measurable increases in malathion than ponds receiving stormwater runoff, such as Van Cortlandt Pond, or the tidal basins of Jamaica Bay, such as Paerdegat Basin.

Naled

The results of the Tier I ecological risk assessment presented in the natural resources impact assessment estimated an exposure concentration of naled from aerial application at a rate of 0.1 pounds of active ingredient per acre as 0.0112 mg/L in a pond and 1.76 mg/L in runoff. The estimated exposure concentration of naled from ground application at a rate of 0.0200 pounds of active ingredient per acre was 0.0022 mg/L for the hypothetical pond and 0.3531 mg/L for surface run-off. The HQ calculated for naled as part of the ecological risk assessment indicates a potential effect to aquatic organisms. These projected exposure concentrations do not take into account half-life, and for the hypothetical pond scenario, assume that all of the adulticide is deposited on the surface. The estimated exposure concentrations suggest that for surface waters such as ponds or lake such as the water bodies of Central Park within the Upper East Side representative study area, Van Cortlandt Lake within Jerome Park/Van Cortlandt Park South representative study area, or Acme Pond and Wolfe's Pond within the Lemon Creek/Wolfe's Pond representative study area, or streams with a low flow volume, the application of naled at the labeled rate for mosquito control may result in negative effects to water quality. However, these increases in adulticide concentration should be short-term because of the short half-life reported for naled in water. Larger water bodies such as those of the New York Harbor system should not be measurably affected by the application of naled for mosquito control because of their large volume of water and naled's fairly rapid dissipation in the environment.

PYRETHROIDS

Active Ingredients

Permithrin

Permethrin is not likely to enter the water column and affect water quality even if it is carried to surface water bound to soil particles. Permethrin carried by surface runoff to CSOs should also bind with organic matter in the CSOs. As for all the adulticides, setback from water bodies as part of the Proposed Action should minimize water quality impacts from drift and deposition. The estimated exposure concentration for permethrin derived as part of the Tier I ecological risk assessment is 0.0053 mg/L in the hypothetical pond from aerial application, and 0.8297 in runoff from aerial

application; and 0.0024 mg/L in the hypothetical pond from aerial application and 0.3707 mg/L in runoff from truck application. The HQ calculated for permethrin using the estimated exposure concentration in the Tier I risk analysis indicates it has the potential to cause adverse effects in fish and crustaceans. However, these estimated concentrations did not assume any partitioning of the adulticide to soil or sediments (which this adulticide tightly binds to), setbacks from the surface water, or degradation of any kind. Therefore, the possible concentration of permethrin in surface waters is likely over estimated.

The Tier II assessment for the pond and runoff scenarios incorporated partitioning to sediment and organic carbon. The estimated concentration of permethrin (0.000303 mg/L with partitioning) was less than the exposure concentration estimated for Tier I. Although lower, the HQs suggest possible effects to certain groups of aquatic organisms. The estimated concentration in runoff was less than the concentration in Tier I, which suggests that the concentrations should be lower with partitioning to sediments in the receiving water body and degradation in the water.

Resemethrin

Resmethrin has been found to be tightly bound to soil and is not expected to be mobile or to contaminate ground water. In aquatic systems it will partition to the sediment from water. The estimated exposure concentration for resmethrin derived as part of the Tier I ecological risk assessment is 0.0008 mg/L in the hypothetical pond from aerial application, and 0.1236 mg/L in runoff from aerial and truck application. The HQ calculated for resmethrin in the Tier I risk analysis indicates it has the potential to cause adverse effects in fish and crustaceans. Because the estimated concentrations did not assume any photodegradation or partitioning of the adulticide to soil or sediments, it likely overestimates the possible concentration of resmethrin in surface waters. However, implementation of the same setback requirements used for sumithrin in New York City for 2000, and the tendency of this adulticide to bind to sediments and to photodegrade on surfaces, soil and water, should minimize water quality impacts associated with the application of resmethrin at its labeled rate.

As discussed for permethrin, the Tier II assessment for the pond and runoff scenarios estimated concentrations of resmethrin, taking into account partitioning with sediments in the pond, and with organic carbon on the land surface. The estimated concentration with partitioning (0.00000163 mg/L) is much less than the Tier I estimated concentration. The concentration in runoff estimated as part of the Tier II assessment is also less than the Tier I exposure concentration. This suggests that the tendency of this pesticide to bind to organic carbon, plus degradation that occurs in sunlight and water, should reduce the concentration in the water.

Sumithrin

During the spray events conducted by the City from July through September 2000, the adulticide Anvil was applied primarily by truck at the labeled ultra low volume (ULV) application rate for this method at 0.0036 pounds of active ingredient (sumithrin) per acre. (The monitoring of PBO from year 2000 actions in New York City are also included in this discussion.) Some areas of Staten Island that were inaccessible by truck were sprayed by air at the same application rate. In order to address the risk of impacts to natural resources, NYSDEC requested that the City sample specific water bodies within the spray zones before and after the spray event; inspect the specified water bodies within 24 hours of spraying to check for fish kills or other impacts; establish for aerial applications a 300-foot no-spray setback from open water bodies, surface waters with emergent marsh vegetation, and tidal regions; establish for ground applications a 100-foot no-spray setback around water bodies; and prevent ground spraying on approaches and bridges over surface waters.

NYCDOH sampled 32 locations for sumithrin and PBO before and after spraying events during the mosquito adulticide applications that occurred during July through September 2000. These locations included the following:

- Staten Island—Clove Lake, Brady's Pond, Eib's Pond, Old Mill Pond, Mt. Loretto Pond, Porzio's Pond, Sharrott's Pond, Mariner's Marsh, Ohrback Lake, Camp Pouch, and Willow Brook Park.
- Queens—Douglaston Golf Course Pond, Forest Park Golf Course Pond, Alley Park Pond, Bay Terrace/Clearview Golf Course, Baisley's Pond/Springfield Gardens, Meadow Lake/Flushing, Springfield Park Pond, Brookville Park/Conselyea's, and Kissena Park Pond.
- Manhattan—the Lake, Harlem Meer, and Turtle Pond in Central Park.
- Bronx—Harlem River, Crotona Park, Hunt's Point/Bronx River, Pelham Bay/Split-Rock Golf Course, and Van Courtlandt Park Pond.
- Brooklyn—Canarsie/Fresh Creek Basin, Prospect Park Lake, Greenwood Cemetery, and Poly Prep Country Day School.

The locations of sampling and the sampling protocol were specified by NYSDEC (Cryan 2000). Out of the 68 post-application samples collected by the City, only two had concentrations of either sumithrin or PBO greater than the 0.5 µg/L Practical Quantitation Limit (PQL): 1.10 µg/L (0.0011 mg/L) for sumithrin on August 18, 2000, at Mt. Loretto Pond on Staten Island; and 1.03 µg/L (0.00103 mg/L) for PBO and 0.55 µg/L (0.00055 mg/L) for sumithrin for a sample collected on August 5, 2000, at Alley Park Pond in Queens. The PBO concentrations are less than the projected worst case concentrations for PBO estimated in the Tier I ecological risk assessment presented in the natural resources impact assessment (0.0024 mg/L in a pond and 0.3707 in runoff from truck and aerial application), which, when evaluated as part of the Tier I Ecological Risk Assessment, did not indicate potential risk to aquatic organisms. For sumithrin, the 0.55 µg/L concentration is close to the worst case surface-water concentration in a pond (0.0004 mg/L) estimated for aerial and ground application, that when evaluated as part of the Tier I ecological risk assessment, indicated a potential adverse impact to aquatic organisms, but is less than the estimated worst case concentration in runoff estimated for aerial and ground application (0.0636 mg/L). The 1.10 µg/L concentration for sumithrin is greater than the worst case surface-water concentration estimated in a pond for both aerial and ground application for which the estimated HQ suggested some risk to fish. However, this concentration is still considerably less than the worst-case runoff concentrations used in the Tier I risk assessment.

Although the one sample at Mount Loretto Pond does suggest some change in water quality through the presence of sumithrin, there were no reported observations of impacts to aquatic organisms. The concentrations of sumithrin and PBO were less than the 0.5 µg/L PQL at this location and the other locations for other spray events, in spite of repeated applications in some areas such as Staten Island. The 0.5 µg/L PQL can be considered the maximum concentration of sumithrin and PBO at these locations, and the concentration of these two adulticides was probably less than this in many cases. All of this suggests that the application of sumithrin with PBO during the summer and fall of 2000 had little effect on water quality. Future applications of this combination of active ingredients should also have minimal effect on water quality provided similar setback requirements and the other protective measures outlined above are followed.

Synergists

Piperonyl Butoxide

For these analyses, PBO was considered to be an active ingredient. PBO is not expected to volatilize or adsorb to sediment; because of this it is expected to leach from soil and be released in water. It has been found to be resistant to hydrolysis and stable to light. However, in the presence of photosensitizers it may photodegrade in surface waters. Otherwise its degradation in the aquatic environment is unknown. The results of the post-spray monitoring conducted in 2000 are discussed above under "sumithrin."

The exposure concentration resulted in HQs that did not suggest potential adverse impacts to aquatic organisms. The fact that the City's post-spray monitoring program collected only two samples where the concentration of PBO was above the practical quantitation limit suggests that the methods of application and the 100-foot setback from surface waters should minimize the introduction of this adulticide to City waters.

Inerts

Chapter 3.C discusses the inert ingredients contained in the adulticides evaluated in this EIS. In most cases the inerts consist of petroleum distillates or white mineral oil. Mineral oil is included in USEPA's list of minimal risk inert ingredients, which include substances which are ubiquitous in nature and not expected to present a hazard to human health or the environment. The amount that would make its way into the City's waters should not affect water quality or aquatic organisms. With respect to petroleum distillates, the volume applied in these ULV formulations will be small, and some of the volume applied will volatilize in the atmosphere or on the ground surface before it reaches the City's waters through stormwater runoff or CSO. Based on the application rates, the range of inerts in pyrethroids range from 3 to 118 times the application rate for sumithrin. Even without the benefit of estimating the volatilization of petroleum distillates, proportioning the sumithrin results by a factor of 118 would result in incremental water quality levels of petroleum distillates that are extremely small. Therefore, the amount of these inerts that would eventually enter the City's waters will be small and inconsequential compared to other sources of these compounds from the region, and should not result in significant impacts to water quality.

3.G INFRASTRUCTURE

There are no expected adverse impacts on the City's sanitation, roadways, bridges, tunnels, wastewater collection, and public transportation from the proposed *Mosquito-Borne Disease Control Program*.

3.H HAZARDOUS MATERIALS

All contractors involved in the *Mosquito-Borne Disease Control Program* will be responsible for proper transportation, storage, and disposal of potentially hazardous materials and for the proper reporting and cleanup of any spills. The U.S. Department of Transportation (USDOT) regulates transport of hazardous materials, including adulticides. The organophosphate pesticides naled and malathion are both subject to hazardous materials transport regulations. USDOT hazardous materials regulations require that these materials must be shipped in specified types of USDOT-approved containers and that trucks or other vehicles carrying hazardous materials be placarded with signs indicating the types of materials being transported. All containers must be properly marked and labeled, and all shipments must be accompanied by shipping papers and by emergency response information on the MSDSs.

All adulticides would be required to be stored in accordance with the manufacturers' recommendations. Materials will be kept in their closed original containers, which will be stored upright in a secure, locked, well-ventilated, dry storage area. Stored containers will be protected from ignition sources and extremes of heat or cold. Storage areas would be provided with secondary containment to catch any leaked or spilled materials. Wastes containing adulticides being used in the *Mosquito-Borne Disease Control Program* would be disposed of in accordance with the recommended procedures and regulations promulgated under FIFRA. Excess adulticides that cannot be used or returned to the manufacturer are to be disposed of at a suitable facility, preferably by incineration which results in complete destruction of the adulticide.

Proper packaging, handling, and transporting of adulticides will minimize the possibility of spills. In the event that a spill occurs, cleanup operations will follow the procedures specified on the label of each adulticide container, as well as in the emergency response information that must accompany all shipments classified as hazardous by the USDOT. Cleanup procedures would include the excavation and proper treatment and disposal of any soil contaminated by leaks or spills. Soil concentrations of adulticides resulting from normal application will be far below any applicable cleanup standards or guidelines.

3.I SOCIOECONOMIC CONDITIONS

Both the No Action and the Proposed Action scenarios could result in economic costs and benefits to New York City. The economic costs could include: the money spent in implementing each mosquito-control program; direct medical expenses of people who might become sick, and in severe cases, may die; personal income lost because of time absent from work; and potential effects on tourism, outdoor recreation, and the horse industry.

PROGRAM COSTS

The *Routine Program* includes comprehensive surveillance, education and research, and mosquito breeding prevention and larvae control activities. It is estimated that the *Routine Program* costs about $5.6 million annually. This estimate does not include additional costs such as the NYCDOH's supervision and coordination costs, and New York City Police Department (NYPD) costs related to the public announcements made before spraying is conducted.

The Proposed Action, including the application of adulticides to control adult mosquitoes, could be expected to cost about $3.5 million annually.

DIRECT MEDICAL EXPENSES

Without the proposed *Mosquito-Borne Disease* Control *Program*, the City could experience additional—and possibly more severe—outbreaks of mosquito-borne diseases such as the West Nile virus. If an outbreak were Citywide, as is projected under the No Action scenario, it could result in 208,215 infections, 37,479 febrile illnesses, 1,666 hospitalizations, and 198 deaths (based on a total City population of 8,008,278, as reported by the 2000 U.S. Census of Population.

It is estimated that hospitalizations due to the West Nile virus in the future without the Proposed Action could reach a total annual cost of about $66.5 million. Of the people who could become hospitalized, 42.9 percent or 715 cases would require home health care services for some period of time after being dismissed from the hospital. Approximately 17.1 percent (285 cases) would require such services for a full year. This translates to a total cost of about $1.65 million.

Additional medical costs related to prescription drugs, doctor's visits, etc., would also be incurred by not only the hospitalized cases but also those who developed a febrile illness from the virus.

There are a number of efforts currently underway in New York City that may reduce the costs of asthma in the future. Hospitalizations and the related costs are expected to continue to decline in the future without the Proposed Action.

Implementation of the Proposed Action would reduce the risk of a future outbreak of the West Nile virus or other mosquito-borne diseases by controlling adult mosquito populations. Accordingly, the Proposed Action would reap the benefit of improved public health and reduced medical expenditures since fewer people would contract the virus and become ill. However, as discussed in Chapter 3.C, "Public Health," the Proposed Action may increase the risk of illness as a result of the proposed spraying of pesticides. Based on the attributable risk calculations, on an annual basis, it is predicted that one child between the age of 0 and 14 could become hospitalized from asthma as a result of the Proposed Action in the Representative Areas. As discussed above, the average cost of asthma hospitalizations among children is $6,044 per person. Among adults, the Proposed Action is projected to result in one hospitalized case of asthma every three years for the Representative Areas. The average cost of an adult case of asthma is approximately $11,630. As compared to the current Citywide number of asthma hospitalizations (33,350 cases in 1997), these projections represent a very small percentage.

PERSONAL INCOME

The No Action condition could result in the loss of about $18 million in earnings to individuals and families if half of the projected 198 deaths from West Nile virus involved uninsured persons of 60 years of age. Even if those persons were insured and their survivors received a fixed death benefit in the high range of payments nationally, the potential cost in lost earnings would be about $14.5 million. Hospitalizations would result in approximately $1.5 million in lost (uninsured) income, excluding the costs of the hospitalization. Assuming that all those with febrile infections would take just one sick day, the lost personal income (or income covered by corporate sick leave) would equal about $5 million.

The Proposed Action would generate substantially more economic benefits than its $3.5 million annual cost. For example, if the Proposed Action saves the lives of nineteen 60-year old wage earners (or 1.2 20-year-old wage earners), the economic benefits to individuals and families would equal the program cost. If the Proposed Action reduces sick leave (paid or unpaid) to about 25,600 days, the economic benefits of retained earnings and productivity would equal the cost of the *Mosquito-Borne Disease Control Program*. Although there may be unforeseen long-term effects on personal income potential from the spraying itself, the immediate economic benefits of the Proposed Action suggests that the benefits will outweigh the costs.

TOURISM

The Proposed Action could also affect the City's tourism industry. Without the Proposed Action, tourists may choose to travel elsewhere as a result of future outbreaks of West Nile virus, or the perceived threat of an outbreak. In that case, tourists would spend their money in another city, and sales at New York City establishments such as hotels, restaurants, and entertainment venues could possibly be reduced. Alternatively, tourist activity could decline as a result of the Proposed Action, particularly when tourists are sensitive to the potential health effects (or perceived effects) of spraying pesticides.

Visitor Trends and Spending

The Proposed Action is unlikely to affect tourist trends in New York City significantly, unless there is a significant and well-publicized increase in the number of deaths or infections resulting from the West Nile virus prior to implementation of the Proposed Action. If, as a result of the Proposed Action, the number or rate of deaths and infections does not rise over levels observed in 2000, the recent trends of moderate increases in the number of visitors to the City would likely continue. Comparison of visitation trends and data for 1999 and 2000 with the prior eight years indicates that public reaction to and concern about the unknown effects of the spraying program are likely to have little or no impact on tourism in the City.

In terms of costs, the Proposed Action would have to retain relatively few visitors for the economic benefits to equal the programmatic costs. For example, visitors spent an average of $427 during their trips to New York City in 2000 for lodging, food, entertainment, shopping, and transportation. Thus, the cost of the Proposed Action is equal to the expenditures of just 8,100 visitors to New York City (or about 0.02 percent of the total number of visitors in 2000). In other words, if the Proposed Action kept 8,100 visitors from canceling plans to visit the New York, the *Mosquito-Borne Disease Control Program* would pay for itself in terms of economic benefits to the City as a whole. Given the recent strong reaction by American tourists to the European foot-and-mouth outbreak, retention of foreign tourist expenditures may be a more important benefit of the Proposed Action. For example, international visitors spent an average of $1,005 when visiting New York in 1999. If control of a future outbreak of West Nile virus convinced fewer than 3,500 foreign tourists to follow through with plans to visit New York, their expenditures would equal the cost of the Proposed Action. This represents just 0.05 percent of all foreign visitors to New York in 1999. It appears that the Proposed Action would cost very little in comparison to the economic benefits retained in terms of the tourist industry.

Lodging

The lodging industry attracts the largest portion of visitor expenditures, approximately $5.8 billion in 1999, or about 37 percent of all visitor expenditures in New York City. In 1999, the average visitor spent about $159 on lodging alone. In terms of potential impacts on hotel room revenue, the Proposed Action would need to retain only about 21,760 room nights to equal the cost of the *Mosquito-Borne Disease Control Program*, or about 0.09 percent of the total room nights available annually in the City. As noted above, the effects of the Proposed Action on international tourism would result in significant benefits to the tourist industry. Because the duration of their visits are longer, the foreign tourist spent an average of $394 on lodging in the City in 1999. The Proposed Action would need to retain only 8,800 international visits to New York to equal the cost of the *Mosquito-Borne Disease Control Program*, or about 0.13 percent of all foreign visitors. Avoiding a significant reduction in the number of visitors to the City would be a major economic benefit of the Proposed Action.

OUTDOOR RECREATION

In the future without the Proposed Action, future outbreaks of the West Nile virus (or other mosquito-borne diseases) may occur. If the outbreaks were similar to those experienced in 1999 and 2000, they would be limited to a small geographic area (e.g., northern Queens, as in 1999) and would exhibit a similar rate of human infection (2.6 percent of the local population). In that case, it is unlikely that outdoor recreation would be affected because no noticeable effects were observed during the last 2 years. (Citywide data were examined for the purposes of outdoor recreation. It is possible that local effects could have occurred, but the data were not available at that level.) As discussed above, the New York City Department of Parks and Recreation (DPR) reports that revenue from its special

events and concessions has continued to rise in recent years—despite the outbreaks of West Nile virus in 1999 and 2000 in which several people died. Citywide beach attendance declined in 2000, but that was attributable to the substantially cooler temperatures and greater rainfall. Furthermore, attendance at beaches located within the 2000 epicenter (Staten Island) remained above attendance levels of 1998, when there was no virus outbreak. When northern Queens was the epicenter in 1999, beach attendance in that borough rose to its highest ever.

Alternatively, it is possible that future outbreaks of the West Nile virus will be more severe without the Proposed Action. The outbreak could spread beyond the local epicenter to the entire City, and/or the infection rates among residents could increase. If almost 200 residents die, as projected above, residents would probably alter their recreational activities to some degree, spending more time indoors in order to avoid the risk of being bitten by a virus-infected mosquito. It is possible that a sufficient number of people would change their patterns of activity, thereby making the City's recreational concessions and special events less profitable. In turn, demand for indoor recreational activity (e.g., movies) may rise. However, overall economic conditions would not necessarily be affected because there would be a shift in the *types* of spending as opposed to a *decline* in spending. As long as the average personal budget for leisure/recreation remains the same, overall spending and economic activity would continue at current levels.

If the Proposed Action is implemented, future outbreaks of West Nile virus would be controlled, as they were in 1999 and 2000, or the potential for future outbreaks would be eliminated altogether. Since there were no effects on outdoor recreation during the previous West Nile outbreaks, it is unlikely that there would be any effects under the Proposed Action. However, the spraying of adulticides may alter recreational activity on a temporary basis. For example, when the police make public announcements before the spraying is actually conducted, warning residents to stay indoors, people may choose to postpone their outdoor activities to another time. This temporary effect would not be expected to result in a reduction in park revenues or other sources of recreational income. Concession and special event revenues for the DPR can be expected to rise if the economy remains strong and if weather conditions in the summer are good.

HORSE INDUSTRY

In the future without the Proposed Action, it is possible that additional costs would be incurred by equestrians in New York City as a result of future outbreaks of the West Nile virus. If there are repeated outbreaks and sustained import restrictions, equestrians may choose to move their operations outside of the City and possibly outside of the region. Accordingly, major events currently held in the City may be transferred to other destinations in the United States or to cities abroad. This would represent a loss in revenue for the City as a result of lower visitor attendance and spending, and reduced demand for businesses that support the equestrian events.

If the Proposed Action is implemented, West Nile virus infections among horses in New York City are likely to remain at levels similar to that of past West Nile outbreaks (1999 and 2000). Alternatively, equine infections could decline as a result of either controlling future outbreaks of the virus, or reducing the potential for outbreaks altogether. In either scenario, potential impacts on the horse industry would be smaller than those projected for the No Action scenario. The import restrictions may also be lifted, resulting in savings for the industry.

3.J OPEN SPACE

The application of adulticides is not expected to result in permanent changes to open spaces in any of the seven representative study areas, or the City. However, it may cause some open spaces to be closed to the public during the time period immediately before, during, and shortly after adulticide application.

During the time of year when adulticiding activities would most likely occur (May to October**)** the use of these open spaces may be reduced for a limited period of time on up to ten occasions. Since adulticiding would take place at night, many of the City's open spaces would be closed during periods of application. Adulticiding activities would only prevent the use of open spaces that are currently open past dusk. This reduction in availability of open space resources for up to ten nights each summer would not be significantly greater than the reduction in use of open space resources that would occur in the future without the adulticide application. While the adulticide application would result in the closure of some parks and other spaces for limited times, an increased incidence of adult-mosquito-borne viruses would likely result in similar, if not greater, reductions in use of open spaces during the summer months.

Since adulticiding would occur on a limited number of nights for a limited duration, and since the reduction in use of open spaces would be similar to the reduction that would take place in the No Action condition, the impacts to open space resources would not be considered significant adverse impacts.

3.K CULTURAL RESOURCES

Potential impacts to cultural resources include the physical impacts of the adulticide on historic structures, and changes to the use or enjoyment of historic structures as a result of the adulticiding activities.

Based on the amount of the products that would be applied in a given application and the capability of the products to break down under sunlight conditions, none of the adulticides are expected to cause damage to any building materials or external building surfaces. Therefore, the applications would not be expected to impact physically any cultural resources in any of the study areas. However, as discussed in Chapter 3.B, "Land Use, Community Facilities, Public Policy, and Zoning," during periods of application, the adulticiding activities have the potential to reduce substantially the use of outdoor areas, some of which have been identified as cultural resources.

These cultural resources include numerous historic districts, which encompass streets and sidewalks as well as structures; many houses and mansions, which often contain substantial associated gardens and outdoor areas; and Central Park, in the Upper East Side study area. While the adulticiding activities are expected to reduce or prevent the use of the outdoor components of these cultural resources, such reductions would be temporary in nature—limited to the period of application and potentially to the hours immediately before and after application. As such, the adulticiding activities would not result in significant adverse impacts to any cultural resources.

3.L VISUAL RESOURCES

Visual resources are an area's unique or important public view corridors, vistas, or natural or built features. Visual impacts would include the blocking of a significant view or resource, changes to an urban design feature so that a natural or built visual resource is no longer dominant in an area, or changes to an urban design feature so that the context of a visual resource is altered.

Of greatest concern in the assessment of impacts to visual resources is the degree and nature of the adulticide applications. The applications would potentially occur during the months of May to October. No permanent structures would be created as a result of the adulticide applications, and the applications would occur principally by truck or aircraft. The only short-term visual changes that would occur would be trucks passing through or helicopter/fixed wing aircraft passing over neighborhoods during periods of application. Driving at relatively low speeds, trucks would pass through blocks quickly, as would any police escort vehicles preceding such trucks.

Therefore, the proposed *Mosquito-Borne Disease Control Program* would not result in any significant adverse impacts on visual resources.

3.M TRANSPORTATION

The *Mosquito-Borne Disease Control Program* would not generate any significant new vehicle trips.

Before vehicles would be sent out to a zone targeted for adulticide spraying, NYCDOH would convene with the applicators to identify bodies of water and sensitive natural resources in the target area.

In truck application, all spray systems would be shut off when passing the water bodies and near the approaches to bridges. When applying by truck, applications would not be made on major highways, and on dead-end blocks. The adulticide spray system would be shut off traveling down the block, and turned back on when the truck turns around to travel back up the block, NYCPDR staff would lead the vehicles. In cases where there are limits on internal roadways for truck access, all-terrain vehicles (ATVs) may be deployed to apply the products.

In general, aerial applications of adulticides would occur at a release height ranging from 100 to 200 feet above local grade in any of the Representative Areas, and a buffer zone of 300 feet from water bodies would be observed when adulticides are applied by aircraft under the *Mosquito-Borne Disease Control Program*. Aircraft would fly at swaths on the order of 300 feet apart, and in part due to the difficulty with night flying, aerial applications would typically be performed near sunrise or sunset hours, while trucks would operate at later hours of the night.

3.N AIR QUALITY

The "Public Health" analysis addressed the potential impacts from the active ingredients and inerts within the adulticides under consideration. With respect to air quality standards, the maximum estimated 24-hour airborne concentration of any adulticide product was estimated to be 20.5 micrograms per cubic meter of air, and less than 12 percent of the applied products are expected to be particles less than 10 microns in diameter (i.e., PM_{10}). An even smaller percentage of the adulticides (3 percent) is expected to be fine particulate matter of less than 2.5 microns in diameter (i.e., $PM_{2.5}$). For the calendar year 1999, background levels of PM_{10} in the City ranged on the order of 25-50 micrograms per cubic meter for 24-hour averages (when the applicable standard is 150 micrograms per cubic meter) and 15-25 for annual averages (when the applicable standard is 50 micrograms per cubic meter). Even assuming that all the airborne particulate concentration from adulticides would be PM_{10}, and adding the maximum PM_{10} levels from the Proposed Action to background levels, this would result in 24-hour PM_{10} concentrations that are well below the applicable standard (i.e., 150 micrograms per cubic meter). While the adulticiding actions are estimated in this EIS to occur 10 times in the same location, for analysis purposes, even adding the maximum 24-hour concentration of adulticides to the annual standard (i.e., assuming adulticide applications every day of the year) would result in maximum annual PM_{10} concentrations that are well below the applicable standard (i.e., 50 microgram per cubic meter).

Since the Proposed Action would neither result in a significant number of new ground or aircraft trips throughout the City nor result in any exceedances of PM_{10} air quality standards, the *Mosquito-Borne Disease Control Program* would not result in exacerbations or new violations of any Federal or New York State Ambient Air Quality Standards, and thus, the program would be consistent with New York State Implementation Plans.

3.O NOISE

The noise issues that would be associated with the proposed *Mosquito-Borne Disease Control Program* would include aerial activity of helicopters or small airplanes and trucks for the application of adulticides. This would affect both workers and residents in the surrounding neighborhoods. A noise analysis was performed which consisted of a screening analysis to determine whether noise due to either aircraft (i.e., helicopters or small airplanes) or truck spraying in connection with the *Mosquito-Borne Disease Control Program* would have the potential for resulting in significant adverse noise impacts.

IMPACTS FROM AIRCRAFT OPERATIONS

At the quietest of locations, while the change in the day-night sound level (L_{dn}) values would be insignificant (i.e., less than 1 A-weighted decibel [dBA]), the change in the 1-hour equivalent ($L_{eq(1)}$) noise levels during nighttime hours would be approximately 5-10 dBA, which would be a readily noticeable and significant increase in noise levels. However, both in quiet and even in relatively noisy neighborhoods, peak passbys aircraft noise levels during spraying operations would be noticeable, and produce intrusive short-term noise levels at residences.

IMPACTS FROM TRUCK OPERATIONS

One truck, with a speed of 20 mph, would produce an $L_{eq(1)}$ noise level of approximately 45 dBA at 25 feet. However, each truck would be escorted by a police vehicle with an announcement to warn people about the spraying. This warning vehicle's purpose is to produce announcements that the public can hear, and therefore the police vehicle will produce short-term noise levels that are noticeable and may be considered to be intrusive. Noise from the police warning vehicle and an announcement would produce an $L_{eq(1)}$ noise level of at least approximately 50 dBA at 25 feet. Together, the warning police vehicle announcement and the spray truck would produce an $L_{eq(1)}$ noise level of approximately 51.2 dBA at 25 feet. Therefore, at the quietest of locations, with the Proposed Action, nighttime $L_{eq(1)}$ noise levels would increase from approximately 48 dBA to approximately 53 dBA. This change in noise level, the increase in $L_{eq(1)}$ noise levels, would be approximately 5 dBA, and would be a readily noticeable change in noise levels, which would be a significant adverse impact. More importantly, when the police warning vehicle and the spray truck pass, both in quiet neighborhoods and neighborhoods that are not particularly quiet, the vehicles will produce short-term passby noise levels that are likely to be noticeable and intrusive to residents.

3.P WATERFRONT REVITALIZATION PROGRAM POLICIES

Because the *Mosquito-Borne Disease Control Program* would be undertaken within the boundaries of New York City's Coastal Zone, it is therefore subject to a consistency review with the New York City Waterfront Revitalization Program (WRP). The WRP, which was approved by and is part of the State's Coastal Zone Management program, consists of 44 Statewide policies and 12 policies specific to New York City.

While the *Mosquito-Borne Disease Control Program* would be consistent with all applicable policies, the program could have impacts on fish and wildlife habitats and resources. Because of this, the program has been developed to minimize potential significant adverse impacts on these resources while still protecting human health. During adulticide spray events, to protect and preserve significant coastal fish and wildlife habitats, the *Mosquito-Borne Disease Control Program* would maintain a 100- and 300-foot buffer around water bodies for truck and aerial application of adulticides. Transportation and storage of adulticides would be conducted in a manner that would minimize the potential for spills into coastal waters. In the event of a spill, mitigation measures have been developed to minimize significant adverse impacts

3.Q UNAVOIDABLE ADVERSE IMPACTS

All of the active ingredients and certain inert ingredients have been linked to skin and eye irritation in humans. There would be potential adverse skin and eye irritation impacts to people who are sensitive to the active and inert ingredients. These adverse effects could occur among workers and residents who are directly exposed to the adulticides, especially due to direct contact near the point of application. While these potential adverse impacts would be reduced by public information announcements (both in the media and by police vehicles escorting ground applications), it is assumed that not all of the population would be able to avoid direct contact with the adulticides, and, therefore, this would result in potential unavoidable adverse impacts from skin and eye irritation.

The predicted potential significant adverse impacts on crustaceans from runoff if rain occurs after applications of malathion over a large land area (such as Brooklyn and Queens which drain into Jamaica Bay) would be unavoidable significant adverse impacts. Crustaceans in Jamaica Bay and similar inlet bays with stormwater outfalls and limited tidal flushing would potentially be impacted by malathion. Although not expected to be significant adverse impacts, there would be predicted unavoidable adverse impacts from the application of adulticides to aquatic life from stormwater runoff. With the projected maximum number of adulticide applications—up to10 in the same area over a 3-month period, these short-term losses in localized areas near the discharge of runoff after a rain event are not expected to significantly reduce individuals at the population level. It is expected that individuals of the same species would repopulate areas that are affected by such localized losses.

There would also be some adverse impacts and loss of non-target insects and other terrestrial arthropods from all of the active ingredients as a result of the proposed *Mosquito-Borne Disease Control Program*, and these potential adverse impacts are considered to be unavoidable adverse impacts.

The predicted exceedance of the malathion water quality standard after rain events in runoff from large land areas to tidal creeks would also be an unavoidable adverse impact, as would the predicted exceedance of the malathion water quality standard in Jamaica Bay and similar inlet bays with stormwater outfalls and limited tidal flushing. These impacts were predicted if a large area of the drainage basin is subjected to adulticide applications, and rain occurs after the applications.

If malathion is applied under this program to large land areas which drain to inlet bays, water monitoring of the runoff to such bays would be performed to determine whether the conservative estimates of malathion predicted in the runoff would occur. If the monitored levels are as great as those predicted, this would result in an unavoidable adverse impact.

Potential significant adverse noise impacts from either low flying aircraft or truck application of adulticides with police warning announcements in front of the trucks are expected.

3.R IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There are several resources that would be expended in the operation of the *Mosquito-Borne Disease Control Program*. These resources include fuel in the form of gas and electricity consumed during operations, and the human effort required to plan and implement the program's components. These resources are considered irretrievably committed because their reuse for some purpose other than the project would be highly unlikely.

3.S ENERGY

The proposed *Mosquito-Borne Disease Control Program* is not expected to raise any significant issues related to long-term demands for or significant impacts on the City's energy system. Depending on the method of application of adulticides (e.g., backpack, all-terrain vehicle, truck, or aerial), application activities would require the use of equipment or vehicles. These can either be portable units or vehicles fueled by fossil fuels. Energy consumption associated with the proposed activities would not result in any significant adverse effects on energy fuel resources.

3.T GROWTH INDUCING ASPECTS

The proposed *Mosquito-Borne Disease Control Program* is not expected to alter regional growth patterns, impact residential settlement patterns, affect the growth in employment centers, or significantly induce development within the City.

3.U ALTERNATIVES

The CEQR process requires that alternatives to the *Mosquito-Borne Disease Control Program* be identified and evaluated as part of the environmental review process. The alternatives analysis should present reasonable options for reducing or eliminating project-generated significant adverse impacts, while substantively meeting project goals and objectives; demonstrate a reasonable range of options to the *Mosquito-Borne Disease Control Program*; and compare potential significant adverse impacts under alternative approaches for meeting project objectives. The range of alternatives to be considered is determined by the nature of the specific action and its potential significant adverse impacts, as disclosed by the technical impact assessments. Described below are alternatives to the proposed *Mosquito-Borne Disease Control Program* which were either initially considered by the NYCDOH or suggested during the public scoping process.

One of the goals of the *Mosquito-Borne Disease Control Program* is to protect public health by reducing the potential for the amplification of viruses in mosquitoes that have been identified as vectors of human diseases. The Proposed Action is one component of an Integrated Pest Management program that the NYCDOH has proposed to prevent and reduce human health risk from mosquito-borne diseases. The NYCDOH has proposed adulticiding to help achieve the control of adult mosquitoes carrying viruses known to potentially harm humans in a timely response to surveillance data. The alternatives presented here are evaluated in comparison to the *Mosquito-Borne Disease Control Program*, including the capability of such alternatives to provide a quick and effective response to control adult mosquitoes in portions of the City (or the whole City) where surveillance has indicated a potential threat to public health.

It is unlikely, based on examination of the available literature and information/experience supplied by mosquito-control experts, to control mosquito vectors of disease efficiently and effectively by using any of these alternatives alone. In many cases, they do not provide the flexibility to significantly

reduce the adult mosquito population at numerous potential geographic locations in the relatively short period of time after surveillance data indicate a threat to public health. Adulticides can be used to depress adult mosquito populations in targeted areas in an attempt to significantly reduce the number of infected adult mosquitoes, break the virus cycle of transmission and, therefore, reduce the potential for a public health threat.

Some of the alternatives may be used in addition to the application of larvicides and adulticides to supplement the effectiveness of controlling adult mosquito populations. However, in the case of a public health threat indicated via surveillance, these alternative methods of control will not wholly substitute for an adulticiding plan and the significant reduction of adult mosquitoes.

Due to the variety of alternatives considered, the alternatives in this section are grouped into the following categories:

- No Action;
- Biological Control;
- Alternative Technologies;
- Unauthorized Programs;
- Program Alternatives; and
- Open Marsh Water Management (OMWM).

The No Action Alternative describes the future condition if the *Mosquito-Borne Disease Control Program* is not implemented and the *Routine Surveillance and Control Program (Routine Program)* continues as the complete mosquito-control program. The Biological Control Alternatives would employ biological control measures (e.g., introducing additional organisms—fish, birds, and other insects—that consume mosquito larvae or adult mosquitoes in the environment). Alternative Technologies include the installation of mechanical devices throughout the City to catch and kill adult mosquitoes (e.g., Mosquito Magnets™ and bug zappers). The Unauthorized Programs Alternative includes actions by NYCDOH without obtaining the required approvals beforehand (such as applying larvicides in every potential mosquito breeding location in New York City, including private properties, or mandating the installation of window screens for every City residence). Program Alternatives consist of alternatives that would include most of the elements of the *Mosquito-Borne Disease Control Program,* but would add, eliminate, or change one or more of the program elements (e.g., adding adulticide applications during daylight periods, eliminating voluntary buffer zones near water bodies, including applications of new USEPA and New York State registered insecticides in the future). The Open Marsh Water Management (OMWM) Alternative would involve altering wetlands in the City to provide circulation and flow in these habitats to eliminate potential standing-water mosquito breeding grounds.

NO ACTION ALTERNATIVE

The No Action Alternative examines environmental conditions that would exist if the *Mosquito-Borne Disease Control Program* were not implemented. In this EIS, the No Action Alternative is considered to be the NYCDOH's *Routine Program*, which was subject to the CEQR and State Environmental Quality Review Act (SEQRA) processes and received a Negative Declaration on April 12, 2000. The *Routine Program* involves education and research; routine surveillance of humans, vectors (mosquitoes), and vertebrates (animals); and larviciding of probable mosquito breeding sites (e.g., storm drains/catch basins throughout the City, NYCDEP WPCPs, and stagnant water) to reduce

larvae of mosquitoes that may eventually carry such mosquito-borne pathogens or affect residents of the Rockaways.

Under this alternative, however, there would be the potential for greater adverse impacts to public health as compared to the *Mosquito-Borne Disease Control Program*. If the NYCDOH decides not to undertake adulticiding under the *Mosquito-Borne Disease Control Program*—in addition to undertaking the *Routine Program*—the potential for infected adult mosquitoes to spread pathogens to humans and to impact public health would be greater. The number of severe cases of West Nile virus (or of other viruses resulting from mosquito-borne pathogens) and the number of mildly symptomatic and asymptomatic cases would be expected to be greater under this alternative than under the *Mosquito-Borne Disease Control Program*.

BIOLOGICAL ALTERNATIVES

These alternatives would involve the reduction of mosquito larvae and adult mosquitoes by using biological control organisms such as larvivorous fish, bats, dragonflies, and birds. Under these alternatives, natural predators of mosquito larvae and adult mosquitoes would be considered for introduction to control mosquito populations. In such cases, there would be concern about these newly introduced species out-competing indigenous species and creating an ecological imbalance in the environment. The United States Fish and Wildlife Service (USFWS), Migratory Bird Treaty Act (MBTA), Endangered Species Act (ESA), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and NYSDEC (Article 11) all regulate and generally prohibit the introduction of non-indigenous wildlife.

Biological alternatives considered were:

- Fish and Amphibians,
- Other Insectivorous Organisms (e.g., dragonflies, predacious aquatic beetles, mosquito larvae predators such as hydra and flatworms, and insect parasites),
- Insectivorous Birds, including many native species,
- Insectivorous Mammals, such as bats, and
- Human Vaccination.

Biological control alternatives involve the introduction of animal species (e.g., fish, birds, insects, and mammals) to control mosquito populations. This might have potential significant adverse impacts on natural resources and native populations. Further long-term research and field studies are needed to evaluate the potential impacts of employing any of the biological alternatives that include introducing living organisms into the environment to control populations of existing, native species. As in the cases of the introduced European Starling and plants such as *Phragmites* (Common Reed), native species are outcompeted and the introduced species thrive, in some cases to pest or invasive status. Due to the great number of unknown factors (e.g., habitat and breeding site loss, competition among species for food and resources) that could contribute to the depletion of native populations from the introduction of additional native or non-native species, the Biological Alternatives presented below are unlikely to be employed as stand-alone alternatives to the *Mosquito-Borne Disease Control Program*, which requires immediate action to reduce infected adult mosquitoes, break mosquito-borne virus cycles and threats to public health at potentially numerous locations throughout the City over time.

Fish and Amphibians

Introducing fish or amphibians to any waterbodies—enclosed or open—in the City would only control a small portion of mosquito larvae populations. Infected adult mosquito populations, which fish would be unable to control at all the breeding sites throughout the City, would continue to exist. The freshwater pockets that can appear in the form of puddles and water in containers cannot be stocked with fish or amphibians to control the breeding of mosquitoes. In addition, introducing fish and amphibians would not reduce infected adult mosquito populations (identified by surveillance programs). The unknown ecological effects of introducing fish into an environment with other living organisms could also disrupt predator-prey relationships. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to contract mosquito-borne diseases as effectively as the use of adulticides, and there could be increased public health and ecological impacts from these alternatives as compared to the proposed project.

Other Insectivorous Organisms

Introducing other insectivorous organisms is extraordinarily difficult to employ on short-term notice, and would only control a small portion of mosquito larvae populations. An identified infected adult mosquito population would not be significantly reduced by the introduction of such organisms. The unknown ecological effects of introducing these organisms into an environment with other living organisms could also disrupt predator-prey relationships. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to contract mosquito-borne diseases as effectively as the use of adulticides, and there could be increased public health and ecological impacts from these alternatives as compared to the proposed project.

Insectivorous Birds

Under the Migratory Bird Treaty Act, it is illegal to breed and release additional native and non-native bird species without a Captive Breeding Permit from the USFWS.

In a recent United States Geological Survey (USGS) study (2000), bird-to-bird transmission of West Nile virus was observed. Further research is needed to evaluate factors associated with birds as possible vectors of the virus. Since the best research to date indicates that the West Nile virus is amplified in the bird population, it may not be prudent to encourage breeding bird programs.

Increasing bird populations would not achieve the goal—protecting public health—of the proposed project, given birds' potential to spread mosquito-borne viruses and the relative ineffectiveness of such bird programs in reducing adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to contract mosquito-borne diseases as effectively as the use of adulticides, and there could be increased public health impacts from this alternative, as compared to the proposed project.

Insectivorous Mammals

Some insectivorous mammals, such as bats, prey on a diversity of insects. Mosquitoes comprise only a portion of their diets.

Maintenance of bat boxes and habitats for the additional bat population, as well as the potential impacts on native species from the introduction of additional bats into the City, would be significant concerns related to this alternative. The City maintains a conservative approach to treatment of people exposed to rabies. Installation and maintenance of bat boxes to encourage the growth of existing bat populations would be contrary to the City's position to protect the public from contracting rabies.

There are also many unknown factors related to the possibility of bats as reservoirs of mosquito-borne diseases. Further research is needed to examine how viruses affect bat populations.

Potential significant adverse impacts may be associated with introducing new populations of bats or encouraging the growth of existing bat populations. In addition, if this alternative were employed, previously discussed ecological impacts on predator-prey relationships, habitat, and food resources could occur. Evidence from available research on bats consuming mosquitoes demonstrates that this alternative would not significantly reduce the adult mosquito population to break mosquito-borne virus cycles, and this alternative (as a stand-alone measure) could result in increased ecological and public health impacts, as compared to the proposed project.

HUMAN VACCINATION ALTERNATIVE

At the present time, vaccinations for many mosquito-borne diseases do not exist. Should human vaccine against West Nile virus and other mosquito-borne viruses become available in the future, NYCDOH will investigate the potential benefits from such future programs. This is included in the additional research component of the *Routine Program*. However, at this time, no vaccines against the West Nile virus and many other emerging diseases are available. The CDC Epidemic/Epizootic West Nile virus in the United States: Revised Guidelines for Surveillance, Prevention, and Control, states "Ultimately, the most effective prevention strategy may be vaccination. It is important to support research on the development of both human and equine vaccines."

ALTERNATIVE TECHNOLOGIES

Alternative technologies are considered when potential significant adverse impacts could be reduced by adopting an alternative technology, and/or the alternative technology would be less costly and efficient in meeting the objectives of the project. Alternative Technologies that were identified for adult mosquito control include Mosquito Magnets™ and bug zappers.

Mosquito Magnet™

A Mosquito Magnet™ emits carbon dioxide that attracts biting insects (mosquitoes, black flies, and no-see-ums) within a one-acre area. The mosquitoes are vacuumed into a net and die within 24 hours.

The reliance on Mosquito Magnets™ for mosquito control throughout New York City is infeasible because the units rely upon carbon dioxide as the means for attracting mosquitoes, and there are a plethora of such sources throughout the City that would interfere with the operation of Mosquito Magnets™. Deploying such units on short-term notice at numerous potential locations throughout the City is also impractical, and would only control a small portion of adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to contract mosquito-borne diseases as effectively as the use of adulticides, and there could be increased public health impacts from this alternative, when compared to the proposed project.

Bug Zappers

"Bug zappers" are typically electronic devices with bright lights that are intended to electrocute night flying insects. Approximately 1.75 million bug zappers are sold in the U.S. each year. Bug Zappers kill insects indiscriminately (Rose, 2001).

As the primary method of control, bug zappers (and Alternative Technologies in general) will not be efficient enough to meet the goals and objectives of the *Mosquito-Borne Disease Control Program*. These units require power sources and studies have shown that mosquitoes are only a small percentage of the creatures killed by such devices. Deploying such units on a short-term notice at

numerous potential locations throughout the City is also impractical, and would only control a small portion of adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to contract mosquito-borne diseases as effectively as the use of adulticides, and there could be increased public health impacts from this alternative, as compared to the proposed project.

UNAUTHORIZED PROGRAMS

Additional Larviciding Actions

This alternative would include not only the larviciding efforts under the *Routine Program*, but also potential larviciding actions on every property within New York City, including residential backyards and any observed stagnant pool of water.

The limitations of implementing only an increased larviciding program would be the failure to control adult mosquito populations and the necessity of trespassing on private properties. Although this alternative would be impractical to employ, the residents and workers of the City would likely be exposed to fewer adult mosquitoes under this alternative than under the No Action Alternative. However, even with additional larviciding, once mosquito-borne viruses are detected, the public would have greater exposure to infected adult mosquitoes as compared to that expected with the *Mosquito-Borne Disease Control Program*. Therefore, adverse impacts on public health under this alternative could be greater than those expected with the *Mosquito-Borne Disease Control Program*.

Household Prevention Measures

Under this alternative, window screens would be required in every New York City residence. Other prevention measures include the addition of screen doors and weather stripping where needed to reduce the potential for intruding adult mosquitoes.

It would be nearly impossible for the City to force installation of window screens in all New York City (publicly and privately owned) homes and apartments. Legislation would have to be adopted to direct and enforce this alternative. This alternative would also not protect people who were outside against infected adult mosquitoes. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to contract mosquito-borne diseases as effectively as the use of adulticides, and there could be increased public health impacts from this alternative, as compared to the *Mosquito-Borne Disease Control Program*.

Strengthening the Immune System

This alternative was raised during the public scoping process. Since persons with compromised immune systems may be one of the groups most highly susceptible to encephalitis, under this alternative it was suggested that New York City residents should maintain a lifestyle rich in exercise and a balanced diet. Citizens would also be encouraged to treat their maladies with natural remedies (e.g., eating garlic).

While many people who have died from recent mosquito-borne outbreaks (i.e., West Nile virus) in New York City are the elderly, many people who have been diagnosed as mildly symptomatic and asymptomatic of viruses are in good health, but still can become ill from these pathogens. Even if the entire New York City population tried to cooperate with this endeavor, not all people would be able to improve their immune systems, nor would the educational component be applicable to visitors, who are a significant proportion of the City's overall population during summer months.

The City cannot enforce this alternative on every New York City resident as protection from mosquito-borne diseases. This alternative would require education and cooperation of every New York City resident, and there is no guarantee of effectiveness. It is expected that employing this alternative in lieu of the *Mosquito-Borne Disease Control Program* would create additional risks to public health (especially to segments of the population more sensitive to mosquito-borne pathogens).

Access Approvals

Under this alternative, the NYCDOH would need to request specific approvals for access into federally-owned properties, such as Gateway National Recreation Area, the only National Park within New York City boundaries. Approvals to larvicide and adulticide would be requested if surveillance shows virus positive cases in proximity to the Park boundaries.

Under this alternative, NYCDOH would apply adulticides in Gateway National Park. If such approvals were gained in the future, NYCDOH would work with the National Parks Service to minimize the potential impacts to non-target species from these actions.

PROGRAM ALTERNATIVES

Under this set of alternatives, the *Mosquito-Borne Disease Control Program* would be implemented; however, Program Alternatives or modifications to this Program (e.g., operational decisions and product application decisions) that the NYCDOH has not chosen at this time would be employed. This could include not observing voluntary buffer zones around water bodies; utilizing newly registered adulticiding products in the future; applying additional carriers in adulticide products; spraying naled by truck; and changing the times of application.

Use of Additional Carriers

Currently the *Mosquito-Borne Disease Control Program* does not include the use of additional carriers—chemical compounds added to adulticides to increase effectiveness of product. The Program currently proposes the use of ultra low volume (ULV) applications of adulticides (i.e., using the least amount of product with still proven effectiveness to cover a large area). For the proposed *Mosquito-Borne Disease Control Program*, NYCDOH would add carriers to the adulticides only if required by the product label. Under this alternative, the NYCDOH would consider the addition of carriers (e.g., mineral oils) to ULV adulticides, which would result in a greater amount of inert materials applied per acre.

The use of additional carriers in products may result in greater amounts of inert ingredients in the environment. Therefore, this alternative may have potentially greater impacts on public health, natural resources, and water supply, as compared to those expected from the voluntary limitations under the proposed *Mosquito-Borne Disease Control Program*. If the NYCDOH modifies the *Mosquito-Borne Disease Control Program* at some time in the future to include the use of additives beyond those required as a minimum by the product label, it will be subject to environmental review and assessment pursuant to CEQR and SEQRA.

New Products

Another Program Alternative would be to apply USEPA registered and New York State registered adulticides that become available after this EIS is complete. Application of these new adulticides would be based on research and the experience of other municipalities and states that manage effective mosquito control programs.

Timing of Application

For the proposed *Mosquito-Borne Disease Control Program*, the application of adulticides would occur near dusk, overnight, or at dawn. Under this Program Alternative, the NYCDOH would apply adulticides during daytime periods also, although such programs may be limited due to the tendency of adulticides to degrade in sunlight (and the potential thermal effects from buildings and the ground, which would raise the applied products away from ground/near ground level).

NYCDOH will be monitoring the primary mosquito species that are a threat to humans. If at some time in the future the NYCDOH plans spraying of adulticides during daylight hours to be advisable, such actions would be subject to environmental review and assessment pursuant to CEQR and SEQRA.

Elimination of Buffer Zones

As part *of the Mosquito-Borne Disease Control Program*, the NYCDOH is proposing to maintain a voluntary 100-foot buffer around water bodies during application of adulticides by truck and a voluntary 300-foot buffer around water bodies adulticides by aircraft. Under this alternative, such voluntary buffer zones would not be included in the program.

Not adhering to voluntary buffer zones may have potentially greater impacts on natural resources (i.e., aquatic organisms) than those expected with the voluntary limits in the proposed *Mosquito-Borne Disease Control Program*. However, changes in application technology may develop in the future that may increase the percentage of smaller droplet sizes in the distribution of the adulticides, thereby lessening the overall deposition of adulticides when compared to current application methods. Under such conditions, the potential impacts on natural resources without the buffer zones may be equal to or greater than those predicted for the *Mosquito-Borne Disease Control Program* in this EIS. NYCDOH will be monitoring the effectiveness of its future programs, and may at some time in the future decide that the voluntary buffer zones are having a significant effect on the efficacy of the program. If the elimination of the voluntary buffer zones is recommended in the future, such actions will be subject to environmental review and assessment pursuant to CEQR and SEQRA.

Alternative Applications

Naled application by truck and thermal fogging are alternative application methods for controlling adult mosquitoes. However, spraying naled by truck and thermal fogging of adulticides are not currently envisioned in the *Mosquito-Borne Disease Control Program*. Thermal fogs have been shown to have effectiveness similar to ULV applications; however, they require fuel oil carriers, and naled applications by truck may cause irritation to individuals in the immediate environment after application.

OPEN MARSH WATER MANAGEMENT ALTERNATIVE

Source reduction is the approach of this alternative. Three types of OMWM modifications can be made for marsh areas—tidal ditches, ponds, and pond radials (short ditches)—which are either slightly above or slightly below the spring tide line. All of these are variations of ditch digging to provide tidal flow and circulation to reduce salt marsh mosquito breeding sites.

These types of source reduction and enhancement measures would reduce potential sites for mosquito breeding. However, these activities would potentially reduce only mosquito larvae populations, and would not have an effect on identified infected adult mosquito populations. Although these measures are being actively being pursued by City, State, and Federal agencies, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to contract mosquito-borne

diseases as effectively as the use of adulticides. Therefore, there could be increased public health impacts from this alternative compared to the Proposed Action.

3.V MITIGATION

Potential significant adverse impacts on crustaceans in inlet bays, such as Jamaica Bay and Little Neck Bay which receive drainage (stormwater runoff) from large land areas, were predicted if rain occurs after application of malathion and it drains into the bays. The results of the modeling are intended to yield conservative estimates of the potential active ingredient levels in the water bodies. The City would conduct monitoring for pre- and post-application of malathion in tributaries to these waterbodies should malathion be selected for application at some time in the future on the land area draining into these bays. Post-application monitoring would also be applied if it rained within one week of the application of malathion in the sections of Brooklyn and Queens where malathion had been applied. If the measured levels of malathion are as large as those estimated for the runoff in this EIS, these impacts would occur and remain unmitigated.

If malathion is selected in the future for land areas that drain into Jamaica Bay, these impacts may be lessened, once completion of the CSO holding tank at Paerdegat Basin is fully constructed (which will reduce the direct discharges into the bay after rainfall).

NYCDOH may elect to apply the active ingredients in smaller droplet sizes (e.g., average mean diameter less than 30 microns) in these areas, because studies in other parts of the country have shown that smaller droplet sizes substantially reduce the amount of the active ingredient that reaches the ground and, therefore, less would run off if a rain event occurs after the application. Also, application by aircraft with smaller droplets would also reduce the potential for runoff into such inlet bays.

Potential significant adverse water quality impacts from the *Mosquito-Borne Disease Control Program* were predicted from the application of malathion. The water quality standard (0.1 µg/L for certain classes) for this active ingredient would be exceeded in storm water runoff for short time periods after spray events. Malathion water quality standards could be exceeded for short periods of time (e.g., rainfall immediately after spray event) as a result of the presence of malathion in runoff into streams (i.e., tidal creeks) that flow into larger water bodies, such as Lemon Creek, and inlet bays with large stormwater discharge and limited tidal flushing such as Jamaica Bay and Little Neck Bay. These predicted exceedances of the malathion standard result from conservative projections, and the City would monitor runoff to determine if those concentrations are observed if malathion is applied in the future.

Potential significant adverse impacts from the *Mosquito-Borne Disease Control Program* were predicted from aircraft and police escort/truck operations. At the quietest of locations in New York City, the change in $L_{eq(1)}$ noise levels during nighttime hours would be approximately 5-10 dBA, which would be a readily noticeable and would be considered to be a significant increase in noise levels. However, both in quiet and even in relatively noisy neighborhoods, peak passbys aircraft noise levels during spraying operations would be noticeable, and produce intrusive short-term noise levels at residences. These impacts would result from relatively low flying aircraft, which would have to fly at limited heights (between 100 to 300 feet) in order for the adulticides to be effective. Therefore, such impacts could not be mitigated.

In addition, each truck would be escorted by police vehicle with an announcement to warn people about the spraying. This warning vehicle's purpose is to produce announcements that the public can hear, and, therefore, it will produce short-term noise levels that are noticeable and may be considered

to be intrusive. Noise from the police warning vehicle and an announcement would produce an $L_{eq(1)}$ noise level of at least approximately 50 dBA at 25 feet. Together, the warning police vehicle announcement and the spray truck would produce an $L_{eq(1)}$ noise level of approximately 51.2 dBA at 25 feet. Therefore, at the quietest of locations, with the Proposed Action, nighttime $L_{eq(1)}$ noise levels would increase from approximately 48 dBA to approximately 53 dBA. This change in noise level (the increase in $L_{eq(1)}$ noise levels would be approximately 5 dBA), would be a readily noticeable change in noise levels, which would be a significant adverse impact. More important, when the police warning vehicle announcing the spraying and the spray truck pass, both in quiet neighborhoods and even in neighborhoods that are not particularly quiet, they will produce short-term passby noise levels that are likely to be noticeable and intrusive to residents. Since the function of the police warning announcement is to make the public aware and minimize potential direct impacts on the public, the noise impacts from such operations would not be mitigated.

4.A ROCKAWAYS FRAMEWORK OF THE ANALYSIS

The impact issues of concern for the *Mosquito Population Control Program in the Rockaways* are those associated with application of adulticides to control adult mosquitoes due to concerns about the health and well-being of citizens in the Rockaways. Many of the issues related to potential exposure, and the fate of products in the environment with respect to adulticides, are similar to the issues discussed for the *Mosquito-Borne Disease Control Program.* These differences in analysis approach were largely due either to the smaller number of exposure scenarios for the environment types on the Rockaway Peninsula (when compared to the whole City) or to the specific program elements that are directly associated with the *Mosquito Population Control Program in the Rockaways*.

PROGRAM LIMITATIONS

The 17 adulticides that may be used on a community-scale basis for mosquito control are also under consideration for the *Mosquito Population Control Program in the Rockaways*. The primary mechanisms for application of adulticides would be via backpack, truck, or all-terrain vehicle (ATV) methods. No aerial applications of adulticides are included in the *Mosquito Population Control Program in the Rockaways*. Buffer zones within 100 feet of water bodies and 100 feet of dune areas near known breeding areas for piping plovers will be observed.

The label-application limits for the products will be adhered to for the *Mosquito Population Control Program in the Rockaways*. No additives or additional carriers (besides the minimum that may be required for a product) will be added to the ULV applications.

Simulations of ground applications (i.e., truck) were performed at a release height of 12 feet above ground. Since there would be no aerial applications of adulticides, only the results from truck applications were considered.

The results of the maximum predicted airborne concentrations and depositions from ground applications of the active ingredients for each of the six products with the highest concentration of active ingredients are the same as those shown in Tables 3.A-5 and 3.A-6. The results are given for the concentration estimated at pedestrian-level height and the maximum from all other modeled heights.

It is not possible to predict exactly where in the Rockaway Peninsula it may be necessary to apply adulticides to control adult mosquitoes in a given year. In large measure, these sites will be determined by surveillance and complaint data, and the likely habitat for mosquitoes. However, it is possible that at one time or another, most land uses in the Rockaway Peninsula and all of its natural

areas could be affected by spraying. Therefore, six typical environments within the Rockaways were identified for analysis, with emphasis on those that may be particularly vulnerable to the application of adulticides.

Representative Areas for EIS Analysis

Four representative geographic areas of the Rockaway Peninsula were selected for site-specific study. One additional area, the "western Rockaways" (see section 4.B), would not be subject to adult mosquito control efforts under this program. Figures 4.A-1 and 4.A-2 depict the Rockaway Peninsula and study areas. As shown on Table 4.A-3, the Rockaway Peninsula includes many of the environment types found in New York City, some likely mosquito breeding grounds, and locations of vulnerable human populations and animal species.

Table 4.A-3
Rockaway Peninsula Environment Types

Environment Types	Present on Peninsula
Residential	
Low-rise	X
Mid-rise	X
High-rise	X
Parks/Open Areas	
Public open space	X
Paved open areas	X
Unpaved open areas (including residential front and rear yards)	X
Marinas/Waterfront Recreation (i.e., beach, boating)	X
Natural Resources	
Upland forest	
Upland field	X
Tidal wetland	X
Freshwater wetland	
Water supply	X
Sensitive waterbodies (including estuaries, rivers, basins)	X
Community Facilities/Institutional Uses	
Schools	X
Hospitals	X
Elder care centers	X
Commercial	
Retail	X
Outdoor dining	
Open markets	
Large Vacant Parcels	X
Industrial/Transportation	
Municipal facilities (including transfer stations, WPCP, depots)	X
Manufacturing/warehouse	
Rail/transit system	X
Major arterials/highways	

Source: Allee King Rosen & Fleming, Inc., November 2000.

During spraying application, adulticide formulations will be dispersed in air, and may settle and leave a residue directly on an individual's skin, due to dispersion and spray drift. Adulticide residues may

also settle on non-targeted outdoor surfaces (such as lawns, gardens, and swimming areas) and surfaces within homes (through open windows or ventilation systems). There is also the potential for insecticides to enter public water supply systems. (For the Rockaway Peninsula, this would be underground aquifers below the peninsula.) Potential impacts from inhalation, dermal contact or ingestion of adulticides were considered in the public health analysis. Potential impacts to terrestrial and aquatic receptors (through direct or indirect exposure) were considered in the natural resources impacts assessment.

Considering the potential areas for adulticide applications, vulnerable human and natural resource populations, and the environment types, the exposure scenarios within the Rockaway Peninsula are discussed below.

Environment Types Particular to the Public Health Analysis:

- Range of residential conditions;
- Schools;
- Nursing Home;
- Hospital;
- Parks;
- Beach; and
- Paved and Unpaved Parks.

Environment Types Particular to the Natural Resources Analysis:

- Natural areas/parks bordering Jamaica Bay (including Grass Hassock Channel);
- Open Areas bordering Rockaway Beach/Atlantic Ocean; and
- Piping Plover endangered species habitat.

Several assumptions were used in the modeling to yield conservative estimates of the adulticide concentrations and deposition levels resulting from adulticiding activities. The same assumptions employed for the *Mosquito-Borne Disease Control Program* were applied for this program, with the exception that only trucks would apply products, and the estimated reapplication of adulticides in a given neighborhood would be expected to be less frequent. Given the strong tidal influence on mosquito breeding in the Rockaway Peninsula, it is expected that spraying of adulticides would occur up to two times a month (a couple of weeks apart) for up to 3 months per year.

4.B ROCKAWAYS LAND USE, COMMUNITY FACILITIES, PUBLIC POLICY AND ZONING

In the future without the *Mosquito Population Control Program in the Rockaways*, NYCDOH would continue its *Routine Program* to control mosquito breeding while enhancing existing disease surveillance and public and medical provider education activities. While this *Routine Program* would continue regardless of the *Mosquito Population Control Program in the Rockaways*, the presence of aggressive biting mosquitoes is nonetheless likely to be much greater in the future without the *Mosquito Population Control Program in the Rockaways*. However, programs like the U. S. Army Corps of Engineers proposed habitat restoration in Bayswater State Park, Dubos Point, and Brant Point may help to significantly reduce mosquito generation in these areas. While large numbers of biting mosquitoes are not likely to change land uses on the peninsula, they would prevent the full use

and enjoyment of outdoor spaces for much of the summer, especially at dawn and dusk, when biting mosquitoes are most active.

PROBABLE IMPACTS OF THE PROPOSED ACTION

The NYCDOH *Mosquito Population Control Program in the Rockaways* consists of four components: Mosquito Surveillance, Mosquito Prevention and Control, Education and Outreach, and Research and Evaluation. Of these four components, only some parts of the Mosquito Prevention and Control efforts—such as adulticide application—have the potential for adverse impacts on the use of land.

The application of adulticides under the proposed *Mosquito Population Control Program in the Rockaways* is not expected to directly change the use of land within the study areas. However, like the Citywide application program, it may cause some spaces normally open to public use to be closed immediately before, during, and shortly after application. This would be considered a direct short-term impact to that use.

The EIS conservatively assumes that up to six applications could occur in Rockaways from the end of June through September (up to two per month). As in the case of the Citywide virus-control application (i.e., *Mosquito-Borne Disease Control Plan*), use of outdoor areas would be diminished during the times of application and, most likely, in the hours immediately before and after application occurs. This analysis focuses on these instances, examining the direct impacts of land use closures during these periods. In sum, the effects of the application on land use are not expected be significantly greater than the No Action condition. That is, the public's reduced use of outdoor areas as a result of elevated levels of aggressive biting mosquitoes would be similar to, and may exceed the public's reduced use of outdoor spaces for the short time duration when adulticide applications are performed.

4.C ROCKAWAYS PUBLIC HEALTH

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 from uncontrollably large populations of mosquitoes. One means of adult mosquito population control is adulticide spraying, which in itself may pose a risk to public health. The public health analysis examines the anticipated benefits to public health from adult mosquito control versus the potential for a percentage of the Rockaways 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 Section 3.C of this Executive Summary.

PROBABLE IMPACTS OF THE PROPOSED ACTION

To examine the potential for adverse public health impacts of the Proposed Action, the public health analysis employed three techniques: Literature Review, Risk Assessment, and Epidemiologic and Attributable Risk Analyses. The following sections provide the methodology used, and then present the results and conclusions for each of these analyses.

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 scientific articles as well as government documents. The literature review was conducted as described in Section 3.C of this Executive Summary.

Risk Assessment

The objective of the public health risk assessment is to determine whether the application of adulticides to control the unbearable mosquito populations in the Rockaways may pose a significant human health risk. In a public health risk assessment, there are four steps:

- 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. Using air dispersion and deposition models for the active ingredients in the adulticide products, estimates of the resultant deposition and airborne concentrations and the potential for drift of insecticides from the proposed operations were developed. This information serves as the foundation for the public health risk assessment studies and the evaluation of alternatives.

Hazard Identification

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

Exposure Analysis

In this step of the public health risk assessment, guidance documents are used to develop a range of exposure parameters for the different groups of people identified in each geographical area. See Section 3.C of this Executive Summary for a description of the guidance documents used.

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 (e.g., 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 subpopulations as listed in Section 3.A of this Executive Summary.

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, 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 methods used to quantify potential human exposures to adulticides from the *Mosquito Population Control Program in the Rockaways*, are the same as those described in Section 3.C of this Executive Summary. As described in Section 4.A of this Executive Summary, the *Mosquito Population Control Program in the Rockaways* assumes an adulticide spray schedule of up to two times a month (a couple of weeks apart) for up to three months per year. Therefore, the exposure concentrations for this program are 60 percent of the exposure concentrations estimated for the adulticide application schedule outlined for the *Mosquito-Borne Disease Control Program*.

Toxicity Analysis

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 CSF and unit risk. The methods used in the derivation of the toxicity criteria used in this public health risk assessment are described in Section 3.C of this Executive Summary.

Risk Characterization

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.)
- MOE 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).

The same methodology is used to estimate non-cancer and cancer health risks from exposure to the adulticides from both the *Mosquito-Borne Disease Control Program* and the *Mosquito Population Control Program in the Rockaways*. This methodology is described in further detail in Section 3.C above.

Epidemiologic and Attributable Risk Analyses

Epidemiologic Analysis

To examine the possible impact of adulticiding on asthma exacerbations or respiratory conditions in New York City, NYCDOH collaborated with NYSDOH and CDC to develop analytic plans that would use existing data on emergency department/urgent care visits and hospitalizations and that would make best use of data available on adulticiding. The methodology employed in this epidemiologic study is described in further detail in Section 3.C of this Executive Summary.

Attributable Risk Analysis

In addition to the epidemiologic study, the potential impacts on changes in asthma rates from adulticide application can be assessed using an "attributable risk calculation." This approach calculates the theoretical percentage increase in asthma hospitalizations that may occur assuming that the population is exposed to additional airborne particulate matter levels, and estimates the additional risk to the asthmatic population (in terms of increased asthma hospitalizations), that may be attributable to the adulticiding actions which would be undertaken as part of the Proposed Action. Increases in asthma hospitalizations would be associated with increased concentrations of particulate matter less than 10 microns in diameter (PM_{10}). The attributable risk calculation employs conservative estimates of population exposure to incremental PM_{10} levels from the applied adulticides.

Based on the three analysis components mentioned above (Literature Review, Risk Assessment, and Empirical Studies), a weight of evidence approach was used in estimating the potential for adverse impacts from the Proposed Action in the Rockaways Peninsula.

CONCLUSIONS

The conclusions from each public health analysis (Literature Review, Risk Assessment, and Empirical Studies) are discussed below.

Literature Review

The conclusions of the literature review are applicable to both the *Mosquito-Borne Disease Control Program* and the *Mosquito Population Control Program in the Rockaways*, and are presented in Section 3.C above.

Risk Assessment

According to the public health Risk Assessment, none of the evaluated human populations (i.e., child and adult residents, workers, homeless people, school children and teachers, park visitors and community gardeners) have HIs (ratios of exposures over non-cancer health criteria) exceeding a value of 1.0 for all active ingredients evaluated in this assessment under average or reasonable maximum exposures. Thus, non-cancer adverse health effects are not expected. Although the HIs (ratios of exposures over non-cancer health criteria) are still below a value of 1.0 for naled, potential exposures to naled resulted in the highest ratios, whereas potential exposures to sumithrin resulted in the lowest ratios for all active ingredients evaluated in this assessment. Because of the various safety factors incorporated in the derivation of the non-cancer health criteria to account for the variability in sensitivity of people, including pregnant women, developing fetuses, the elderly, and the chronically ill, non-cancer adverse health effects associated with potential exposures to the active ingredients are not expected for these individuals.

Carcinogenic risks characterized for the human populations described above are within or below the USEPA-determined acceptable target risk range of less than 0.000001 to 0.0001. The highest cancer risk of 0.0000029 for permethrin estimated in this assessment is for residents (child and adult combined) under reasonable maximum exposures. This value represents the added probability of getting cancer above the background cancer risk typically experienced by all individuals in the course of daily life. The American Cancer Society has determined that the lifetime probability of developing cancer is 43.5% (or one chance in 2.3) in men and 38.3% (or one chance in 2.6) in women (Greenlee et al., 2001).

Although still within acceptable target risk range, the highest risks for all human populations evaluated in this assessment are associated with exposures to permethrin. Cancer risks associated with exposures to malathion are approximately 10 to 100 times lower than risks associated with permethrin.

MOE analysis was performed for resmethrin, sumithrin, and PBO for the child resident (considered as the most sensitive human evaluated in this risk assessment). The calculated MOE for all three active ingredients are approximately 1 to 100 times greater, respectively, than the comparison MOE for these two chemicals. The comparison MOE was selected as an additional safety factor to ensure adequate protection for human health. For the three active ingredients sumithrin, resmithrin, and PBO, the MOE analysis indicates that potential exposures to these three chemicals by resident children is low enough not to be of concern.

Finally, results from the RBC approach to evaluate acute exposures (e.g., inhalation of drift, skin contact with drift while spraying, and ingestion of drift deposited on hands) by resident children indicate that the maximum modeled air concentration for sumithrin, resmethrin, permethrin and PBO occurring within 24 hours of adulticide spraying are lower (up to 10 times lower) than the calculated RBCs. However, the maximum modeled air concentrations for malathion and naled are greater than the calculated RBCs, which would imply that immediate health effects could potentially result from malathion and naled exposures. However, given the conservative assumptions used in this calculation, exposures are likely overestimated. Therefore, considering the conservative nature of the assumptions, and given the short-term (acute) nature of the exposures, exposures to malathion and naled would not constitute a significant adverse public health impact.

Uncertainties in this public health risk assessment exist in numerous areas, including derivation of toxicity values, and estimation of potential exposures to adulticides by human populations. However, where uncertainties exist, conservative inputs or approaches were generally used so that potential risks would be overestimated. Overall, despite the inherent uncertainties associated with this public health risk assessment, the risk estimates calculated in this assessment are conservative, and are likely to overpredict actual risks.

Epidemiologic and Attributable Risk Analyses

The conclusions of the Epidemiologic and Attributable Risk Analyses are applicable to both the *Mosquito-Borne Disease Control Program* and the *Mosquito Population Control Program in the Rockaways*, and are presented in Section 3.C above.

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 Analyses. 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 upon 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 whom have pre-existing sensitizations. 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. Also, 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 suggested 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 exacerbations. 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.

4.D ROCKAWAYS NATURAL RESOURCES

The natural resources within the Rockaway Peninsula were identified. The potential effects of the proposed *Mosquito Population Control Program in the Rockaways* on the resources of the Rockaway Peninsula, using the approach and methodology described above for the *Mosquito-Borne Disease Control Program* were followed. However the analyses were modified to account for the specific natural resources on the Rockaway Peninsula and different program elements associated with the *Mosquito Population Control Program in the Rockaways*.

Because the area is mostly developed, with the exception of vacant lots that provide limited wildlife habitat, and the land set aside as open space, there should be little change in natural resources in the future on the Rockaway Peninsula without the *Mosquito Population Control Program in the Rockaways*. Over the years, development and filling of marshlands, along with other types of ecological degradation, have restricted the natural flushing of the saltmarshes, increasing habitat for the major nuisance mosquito in the Rockaways *Ochlerotatus sollicitans,* as well as other mosquito species. To correct this ecological degradation, the New York District of the U.S. Army Corps of Engineers has tentatively scheduled habitat restoration in Bayswater Point State Park, Dubois Point, and Brant Point beginning in 2003. These improvements will include construction of offshore breakwaters to accelerate the establishment of fringe saltmarshes, removal of a damaged seawall, extending and/or unclogging tidal creeks to promote the free flow of tides, removing unwanted vegetation, and fencing to prevent excessive drifting of sand. The restoration of tidal movement will eliminate pockets of standing water and provide access to these areas for fish to help control mosquito larva.

The results of the Tier I screening analysis from the *Mosquito-Borne Disease Control Program* would also apply to the *Mosquito Population Control Program in the Rockaways*. The pond scenario is the one exception, because there are no ponds on the Rockaway Peninsula. However, the Tier II assessment examines these potential risks using a method tailored to meet the specific circumstances around each risk. Therefore, Tier II assessments were evaluated for the Rockways. The scenarios identified as potential risk were:

- Terrestrial Receptors With Direct Exposure;
- Aquatic Receptors in Wetlands Exposed to Runoff; and
- Receptors Exposed Through the Food Chain.

POTENTIAL IMPACTS FROM ADULTICIDE APPLICATIONS

Potential effects to the natural resources of the Rockaway Peninsula may result from:

- The action of the adulticides on the aquatic and terrestrial animals and plants inhabiting the open spaces within the Rockaways, as evaluated in the Tier I and Tier II ecological risk assessments; and

- The activities associated with the adulticide application methods.

The following sections discuss these two groups of potential effects.

Potential Adulticide Related Impacts

Terrestrial Receptors With Direct Exposure or Exposure Through the Food Chain

The same discussion and conclusions discussed for the *Mosquito-Borne Disease Control Program* with respect to potential direct impacts to non-target insects and indirect impacts to mammals, birds, reptiles, and amphibians would apply to the *Mosquito Population Control Program in the Rockaways*. Based on the results of the modeling analyses, there are no expected adverse impacts to birds and mammals. There are no potential significant adverse impacts from inhalation of the active ingredients, or from ingestion through food, preening in the case of birds, or drinking water from puddles in the case of dogs. There would be potential adverse impacts to certain individual non-target insects. However, the overall impact to the insect community on the Rockaway Peninsula, and any secondary impacts to other groups of organisms that depend on them for food, would not result in significant impacts. The proposed spraying schedule for the Rockaways would provide sufficient time for the insect community to rebound through migration from unaffected areas or through reproduction by unaffected individuals.

Aquatic Receptors in Wetlands Exposed to Runoff

The Tier II assessment conducted for Jamaica Bay for the *Mosquito Population Control Program in the Rockaways* suggests there would be no predicted significant adverse impacts on aquatic organisms from the active ingredients. Additionally, the Tier II assessment, while it took into account partitioning of some of the active ingredients with the land surface, did not take into account partitioning in the storm sewers or CSOs before discharge to the Bay, nor did it take into account partitioning within the water column of the receiving water. When these factors are taken into consideration, the estimated exposure concentration may be lower than that estimated in the analysis. This, combined with the small volume of the discharge from the Rockaways compared to the volume of Jamaica Bay, and the fact that the discharge will not be stagnant within the Bay but will mix with the receiving water, suggests that the potential adverse impacts to aquatic resources of the Bay would not be significant. Fish, because they are mobile, will not be constantly exposed to the active ingredients, unlike the laboratory environment used for the toxicity tests. While some benthic invertebrate individuals have the potential to be adversely impacted by the discharge of storm water or CSOs containing the active ingredients because they are less mobile, benthic invertebrate communities tend to recover quickly such that the benthic invertebrate resources would not be significantly adversely impacted.

Endangered Species

The Federally listed endangered species on the Rockaways Peninsula include the piping plover and seabeach amaranth. The City will not be implementing the *Mosquito Population Control Program in the Rockaways* at Breezy Point or on any other Federal- or State-owned properties, which minimizes the potential impacts to endangered species in these areas. With respect to the Rockaway beach area, the City would minimize impacts by maintaining at least a 100-foot setback from the landward edge of the dune habitat where such breeding habitats have been identified. Impacts to other plant species of special concern found within the Rockaway peninsula, seabeach knotweed in the ocean beach/dune area, and Schweinitz's flatsedge in the tidal wetlands of Jamaica Bay, should be minimized by maintaining the proposed setback from the beach habitats and the 100-foot setback from waterbodies.

Cumulative Effects from the Application of Adulticides and Larvicides

Because of differences in the mode of action between the adulticides evaluated in this EIS and the larvicides that are part of the City's *Routine Comprehensive Arthropod-borne Disease Surveillance and Control Program,* the cumulative effects should be limited. The larvicide Bs targets primarily mosquitoes, and therefore, its application with the adulticides will not result in greater effects to natural resources than the adulticides alone. Bti can affect other dipterans along with mosquitoes, which could result in greater impacts to some groups of dipterans when combined with some adulticides. Methoprene has the potential to affect non-target invertebrates. However, because the City is not proposing to use methoprene in ponds, lakes, or wetlands, the cumulative effect of this larvicide with the adulticides should not pose significant additional risk to natural resources.

Cummulative Effects of Active Ingredients Applied by City With Background

The primary water body with the potential to have background levels of any of the active ingredients within the Rockaway peninsula is Jamaica Bay. The results of background pesticide levels in other water bodies in New York State combined with the results of the City's post-spray water sampling from the 2000 spray events discussed above (which that indicated few instances of sumithrin or PBO in the water bodies sampled from previous applications), suggest that detectable background levels of the adulticides should not be present in the Bay. And therefore, cumulative impacts on natural resources from background levels of pesticides and the proposed *Mosquito Population Control Program in the Rockaways* should be no greater than those discussed above.

INERTS

The primary inert ingredients contained in the adulticides (primarily pyrethroids) which are evaluated in this EIS are petroleum distillates or white mineral oil. USEPA regards mineral oil as generally safe and the amount that would make its way into Jamaica Bay should not affect water quality or aquatic organisms. With respect to petroleum distillates, the volume applied in these ULV formulations will be small. Some of the volume applied will volatilize in the atmosphere or on the ground surface before it reaches Jamaica Bay through stormwater runoff. The amount of these inerts that would eventually enter the Jamaica Bay will be small and inconsequential compared to other sources of these compounds in Jamaica Bay, and should not result in significant impacts to aquatic organisms.

POTENTIAL RELATED IMPACTS

Impacts on natural resources may also occur from:

- Movement of trucks applying the adulticide;
- Lights from the truck application; and
- Other human disturbance associated with the application.

Effects to natural resources associated with the movement of trucks during spraying may include loss of some individual wildlife and birds due to impact with the truck. However, because the trucks move slowly 5 to 10 mph, are noisy and have headlights, no significant adverse impacts are expected from those trucks. Other impacts associated with the movement of trucks may be associated with ground disturbance and creation of ruts should the trucks leave the paved roadways. Because the trucks must maintain a setback from water or wetlands, effects to aquatic resources would be minimal and will not be significant.

Some wildlife and bird individuals would be affected by the noise associated with the truck. These effects may include a change in activity pattern such as cessation of feeding activities or resting, or

change in the resting location. However, these effects would be temporary and non-significant, and normal activity patterns should return once the vehicle or aircraft has passed.

As with the noise effects, the lights from the truck may cause a temporary change in activity pattern such as feeding or resting. However these changes would be temporary and normal activities should return once the vehicle or aircraft has passed.

Any other human disturbance associated with the application of adulticides, such as increased human contact during the spraying would be temporary and short-lived, and will have minimal effect on wildlife or birds.

CONCLUSIONS

The habitats and characteristics of the Rockaways Peninsula were utilized to assist in the evaluation of the potential impacts on natural resources from the Proposed Action. Screening level (Tier 1) and focused (Tier II) ecological risk assessment methods were used to assess the potential risks to biological receptors from the Proposed Action. In addition, assessments were performed to determine the potential impacts from the operations of the mechanical equipment (such as trucks, all-terrain vehicles, and aircraft) on natural resources. The risk assessment calculations were weighted with results from empirical studies, and best professional judgment, to assess the effects and significance of potential impacts of the various active ingredients to resources found in the Representative Areas (and therefore, the City), in accordance with guidelines in the *CEQR Technical Manual* for determining significance.

No significant adverse impacts are expected from the application equipment, including trucks or aircraft applying adulticides, and no significant adverse impacts are expected on endangered species. No significant adverse impacts are expected from the inerts in the adulticides. No predicted significant adverse impacts are expected on birds, pets, or mammals. There would be potential adverse effects on aquatic life near the outfalls of storm water runoff in Jamaica Bay if it rains after an application. In addition, adverse effects would occur to other insects and terrestrial arthropods from direct contact to the adulticides. While there would be losses of individuals in these species, these potential adverse effects are not considered to be significant adverse impacts.

4.E ROCKAWAYS WATER SUPPLY

As discussed in Chapter 3.E, the primary sources of water supply for New York City are surface reservoirs located north of the City. While there are some groundwater supplies, these comprise only a small percentage of the total City water supply. There are, however, locations within New York City that are dependent upon groundwater supplies.

As noted above, a lesser number of applications in the study area is expected under the *Mosquito Population Control Program in the Rockaways* than the maximum number of applications assumed for the *Mosquito-Borne Disease Control Program* analysis. Also, the results of the potential groundwater impact analysis for the *Mosquito-Borne Disease Control Program* showed there would be no significant impacts on groundwater supplies from 10 adulticide applications in one day. Therefore, based on this, no significant adverse impacts on groundwater from the proposed *Mosquito Population Control Program in the Rockaways* are expected.

4.F ROCKAWAYS WATER QUALITY

Jamaica Bay and the Atlantic Ocean are the major bodies of water surrounding the Rockaway peninsula. There are no bodies of water on the peninsula. Surface water quality in Jamaica Bay is

likely to improve in the future as part of the City's program to implement aggressive and innovative measures to control the input of pollutants to Jamaica Bay through developing and upgrading the sewage treatment system, identifying illegal connections to the sewer system, and implementing the multi-year CSO Abatement Program. Other improvements, such as the U. S. Army Corps of Engineers proposed navigational channel and shoreline enhancements, will also ultimately result in improved water quality by stabilizing shorelines, and re-establishing tidal wetlands in some areas.

ORGANOPHOSPHATES

Malathion

The New York State water quality standard for malathion in surface waters is 0.1 μg/L. The estimated exposure concentration for Jamaica Bay calculated as part of the Tier II risk assessment for the *Mosquito Population Control Program in the Rockaways* (Chapter 4.D) is approximately 0.109 μg/L (0.00010895 ppm). Although the HQs calculated from this exposure concentration do not suggest a potential risk to aquatic organisms, it is very close to the water quality standard that suggests that the application as part of the *Mosquito Population Control Program in the Rockaways* has the potential to cause an exceedance of the malathion standard.

Naled

The estimated exposure concentration for Jamaica Bay calculated as part of the Tier II risk assessment for the *Mosquito Population Control Program in the Rockaways* is approximately 0.00007630 ppm, which did not result in an HQ that suggests a potential risk to aquatic organisms. Because Jamaica Bay is a large body of water and naled appears to dissipate in a relatively short period of time, its application as part of the *Mosquito Population Control Program in the Rockaways* should not significantly affect water quality of the Bay.

PYRETHROIDS

Active Ingredients

Permethrin

The estimated exposure concentration in Jamaica Bay from the *Mosquito Population Control Program in the Rockaways*, presented in Chapter 4.D, is 0.00000224 ppm, which did not result in a HQ that suggests a potential risk to aquatic organisms. Because the estimated concentration does not assume any partitioning to the sediment or within the storm sewer or CSO the concentration available within the water column is likely to be lower.

Resmethrin

The estimated exposure concentration for resmethrin calculated for Jamaica Bay from the *Mosquito Population Control Program in the Rockaways*, as presented in Chapter 4.D, is 0.00000002 ppm, which did not result in a HQ that suggests a potential risk to aquatic organisms. As is the case for the other active ingredients, this estimated concentration did not take into account partitioning with organic material in the stormwater system, the CSO, or the Bay, which would result in a lower concentration than that projected.

Sumithrin

The estimated exposure concentration for sumithrin presented in Jamaica Bay is 0.00000016 ppm. Neither of these exposure concentrations resulted in HQs that suggested a potential risk to aquatic organisms. The fact that the City's post-spray monitoring program collected only two samples where

the concentration of sumithrin or PBO was above the practical quantification limit suggests that the methods of application and the 100-foot setback from surface waters should minimize the introduction of this adulticide to Jamaica Bay.

Synergists

Piperonyl Butoxide

For these analyses, PBO was considered to be an active ingredient. The estimated exposure concentration for PBO is 0.00009875 ppm. This exposure concentration resulted in HQs that did not suggest a potential risk to aquatic organisms. The fact that the City's post-spray monitoring program collected only two samples where the concentration of PBO was above the practical quantification limit suggests that the methods of application and the 100-foot setback from surface waters should minimize the introduction of this adulticide to Jamaica Bay.

Inerts

In most cases the inerts consist of petroleum distillates or white mineral oil. USEPA regards mineral oil as generally safe and the amount that would make its way into Jamaica Bay should not affect water quality or aquatic organisms. With respect to petroleum distillates, the volume applied in these ULV formulations will be small, and some of the volume applied will volatilize in the atmosphere or on the ground surface before it reaches Jamaica Bay through stormwater runoff or CSO. Based on the application rates, the range of inerts in pyrethroids range from 3 to 118 times the application rate for sumithrin. Even without the benefit of estimating the volatilization of petroleum distillates, proportioning the sumithrin results by a factor of 118 would result in incremental water quality levels of petroleum distillates that are extremely small. Therefore, the amount of these inerts that would eventually enter the Jamaica Bay will be small and inconsequential compared to other sources of these compounds in Jamaica Bay, and should not result in significant impacts to water quality

4.G ROCKAWAYS INFRASTRUCTURE

There are no expected adverse impacts on the Rockaway Peninsula's sanitation, roadways, bridges, tunnels, wastewater treatment, and public transportation from the proposed *Mosquito Population Control Program in the Rockaways*.

4.H ROCKAWAYS HAZARDOUS MATERIALS

All adulticides would be transported, stored, and disposed of, and any spills of such materials would be cleaned up, following the procedures described in Chapter 3.H, "Hazardous Materials," for the *Mosquito-Borne Disease Control Program*. Handling of adulticides in accordance with these procedures will minimize the potential for any accidental release. If any spills occur, USDEP and NYCDOH will monitor the cleanup to confirm that the specified procedures are followed to protect workers and to prevent any impacts to nearby residents. Post-cleanup sampling will be performed to ensure that affected surfaces have been properly cleaned and that any contaminated soil has been removed.

4.I ROCKAWAYS SOCIOECONOMIC CONDITIONS

As described in Chapter 4.A, "Framework of the Analysis," the proposed *Mosquito Population Control Program in the Rockaways* is intended to improve the well being of residents in the Rockaways by reducing the mosquito population to a reasonable level. Compared to other parts of the City, the Rockaway Peninsula is home to a much larger mosquito population due to the strong tidal

influence on mosquito breeding. Mosquitoes are a nuisance when they become overpopulated in an area inhabited by human beings. However, the particular mosquito species of concern in the Rockaways does not carry diseases like the West Nile virus. Therefore, the following analysis of potential economic costs and benefits does not address medical costs, personal income, or the horse industry. Program costs, tourism, and outdoor recreation are analyzed using a framework and methodology similar to that presented in Chapter 3.I, "Socioeconomic Conditions."

EXISTING CONDITIONS

Program Costs

The City's *Routine Program* includes comprehensive surveillance, education and research, and mosquito breeding prevention and larvae control activities. Based on the proportion of catch basins located in the Rockaway Peninsula, it is estimated that approximately $151,390 or 2.7 percent of the annual Citywide costs for the *Routine Program* are attributed to the routine activities conducted on the Rockaways. Following the Citywide distribution, about 38 percent of the cost would be allocated to larviciding, 25 percent to mosquito surveillance, 19 percent to health education, and 18 percent to human, mammal, and bird surveillance.

Tourism

The Rockaway Peninsula used to be a major tourist destination with a seasonal community of beachfront bungalows. Although the peninsula is still a prime summertime destination, it is now a full-time community of year-round residents. Rockaway Beach, the Boardwalk, and Jacob Riis Park continue to draw a substantial number of visitors each year, most of whom are residents of New York City as opposed to tourists from beyond the City limits.

With a supply of approximately 5,100 hotel rooms, the borough of Queens offers the largest number of lodging opportunities after Manhattan, as reported by Smith Travel Research. There are no hotel properties in the Rockaways, however. Lodging is concentrated around the borough's two airports: John F. Kennedy International Airport, north of the Rockaways across Jamaica Bay, and LaGuardia Airport in northern Queens. Most of the hotel demand in Queens is generated by business travelers, as opposed to leisure travelers or tourists who would potentially visit the recreational resources on Rockaway Peninsula. Hotel performance, including occupancy, has risen over the last 7 years, following Citywide and national trends in the lodging industry (see Table 4.I-1). The average annual occupancy rate was 83.9 percent in 2000, just below the Manhattan rate of 84.1 percent. The average room rate of $136.16 was well below the Manhattan rate of $219.71. These performance indicators do not show any discernable economic effects from the excessive mosquito population in the Rockaways. Hotel operations near the JFK International Airport, given their proximity to the Rockaways and Jamaica Bay, may have taken precautionary measures to keep mosquitoes away from their outdoor facilities (e.g., swimming pools) and hotel patrons, but overall operations were probably the same as any other year.

Outdoor Recreation

The Rockaway Peninsula contains a number of outdoor recreational resources, most notably Rockaway Beach, which runs the entire length of the peninsula along the Atlantic Ocean from Beach 3rd Street, just west of the Queens/Nassau border, to Jacob Riis Park. From Beach 3rd Street to Beach 126th Street, the Rockaway Boardwalk lines the beach. While not heavily used during fall, winter, and spring, the boardwalk and beach attract between 3.5 to 4.5 million visitors during the summer months, as shown in Table 4.I-2. Compared to other beaches in New York City, Rockaway Beach

Table 4.I-1
Hotel Market Performance, Manhattan and Queens

Year	1994	1995	1996	1997	1998	1999	2000
Manhattan							
Average Occupancy Rate (%)	75.5	78.7	80.7	81.9	82.5	82.0	84.1
Average Room Rate	$133.60	$143.59	$160.04	$175.74	$192.19	$202.92	$219.71
Queens							
Average Occupancy Rate (%)	78.3	78.9	80.3	75.5	77.2	79.7	83.9
Average Room Rate	$93.23	$99.53	$110.95	$118.80	$123.53	$127.9	$136.16

Source: Smith Travel Research

Table 4.I-2
Beach Attendance Trends in the Rockaways

Number of Visitors		
1998	**1999**	**2000**
4,434,450	4,508,649	3,530,236

Source: DPR

draws the greatest number of visitors, almost 4 times as many visitors as Orchard Beach in the Bronx and Coney Island in Brooklyn.

Following Citywide trends in beach attendance, attendance at Rockaway Beach rose between 1998 and 1999, and declined substantially between 1999 and 2000. Citywide beach attendance reached its highest level ever in 1999, when the West Nile virus was first discovered at the end of the summer (August). DPR attributes the decline in beach attendance in the summer of 2000 to poor weather conditions, including rain and cool temperatures that occurred on major holiday weekends. Potential economic effects in the Rockaways from the large numbers of biting mosquitoes cannot be discerned using the attendance data since beach-going is influenced by a variety of factors. In addition to weather, these factors can include sea conditions (water quality, red tide, wave height, etc.), surface conditions of the beach itself (litter and other debris), as well as economic conditions. As noted in Chapter 3.I, "Socioeconomic Conditions," the wealth effect experienced during a robust economy encourages people to travel outside the City to attend other beaches or resorts.

There are three food service concessions that operate on the Rockaway Boardwalk at 17th, 86th, and 97th Streets. Revenues generated by these concessions typically follow patterns in beach and boardwalk attendance.

Other outdoor recreational resources located in the Rockaways include Fort Tilden and Jacob Riis Park in the Western Rockaways, Bayswater Point State Park, Dubois Point Wildlife Sanctuary (which has been identified as a prime mosquito breeding ground), several neighborhood parks and playgrounds, and athletic facilities associated with the Beach Channel High School Campus and Far Rockaway High School. These resources do not generate direct revenue for the City, although food service establishments nearby (delis, ice cream shops) may benefit from the recreational activity.

Although the available data do not indicate any adverse economic effects from large mosquito populations in the Rockaways, there is some qualitative evidence that they prevent the full use and

enjoyment of outdoor recreational resources during much of the summer, especially at dawn and dusk, when biting mosquitoes are most active.

FUTURE WITHOUT THE PROPOSED ACTION

Program Costs

In the future without the *Mosquito Population Control Program in the Rockaways*, DOH would continue its *Routine Program* to control mosquito breeding while enhancing existing disease surveillance, and health education activities. While this *Routine Program* would continue regardless of the Proposed Action, the presence of aggressive biting mosquitoes is likely to be the same as that experienced during recent summers, or it may grow even larger in the future without the Proposed Action. However, programs like the U. S. Army Corps of Engineers' proposed habitat restoration in Bayswater State Park, Dubois Point, and Brant Point may help to significantly reduce mosquito generation in these areas. As described above, the total annual cost of the *Routine Program* in the Rockaways is approximately $151,390.

Tourism and Outdoor Recreation

As noted above, the presence of aggressive biting mosquitoes in the Rockaways is likely to be either the same or much greater in the future without the Proposed Action, regardless of the City's *Routine Program* for surveillance, education and research, and mosquito breeding prevention and larvae control activities. Without adult mosquito control measures in place, residents, tourists, and other visitors may alter their recreational activity to some degree in order to avoid the risk of being bitten by mosquitoes. This could mean either spending more time indoors, or staying indoors at dawn and dusk, when biting mosquitoes are most active.

It is possible that a sufficient number of people would change their patterns of activity, thereby making the Rockaways' food service concessions along the Boardwalk and any local outdoor events less profitable. In turn, demand for indoor recreational activity (e.g., movies) may rise. However, overall economic conditions would not necessarily be affected because there would be a shift in the *types* of spending as opposed to a *decline* in spending. As long as the average personal budget for leisure/recreation remains the same, overall spending and economic activity in New York City would remain unchanged.

If future mosquito populations remain the same as those experienced during the last few summers, outdoor recreation on the Rockaway Peninsula may not be affected because no noticeable effects were observed during that period. However, there is some qualitative evidence that mosquito populations during those years prevented the full use and enjoyment of outdoor recreational resources during the summer, especially at dawn and dusk, when biting mosquitoes are most active.

The closest hotel properties, located around the John F. Kennedy International Airport across Jamaica Bay, may continue to take precautionary measures as mosquito populations in the Rockaways either stay the same or grow larger in the future without the Proposed Action. In either case, such measures are not expected to affect hotel performance or overall economic conditions in the local hotel industry.

PROBABLE IMPACTS OF THE PROPOSED ACTION

Program Costs

The proposed *Mosquito Population Control Program for the Rockaways* would cost approximately $69,000 annually based on 6 applications per year (twice a month for up to three months per year).

This estimate does not include additional costs such as the neighborhood warnings/announcements made by the NYPD before the spraying is conducted, coordination and supervision efforts of the NYCDOH staff, etc.

Tourism and Outdoor Recreation

By controlling the population of mosquitoes in the Rockaways, the Proposed Action will reduce the presence of mosquitoes to reasonable (and bearable) levels, levels at which they would create less of a nuisance. A reduction in the mosquito population in the Rockaways could benefit the hotels located near JFK International Airport, just across Jamaica Bay, by reducing the need for precautionary measures. Patrons of the hotels may be able to more fully enjoy outdoor hotel facilities such as pools, tennis courts, etc. On the Rockaway Peninsula, conditions for outdoor recreation may be improved, although no noticeable effects of the existing mosquito population were observed in beach attendance trends over the last few years. Compared to the future without the Proposed Action, tourism near the Rockaways and outdoor recreation on the peninsula itself would benefit from a reduced mosquito population.

INFRASTRUCTURE

There are no expected adverse impacts on the Rockaway Peninsula's sanitation, roadways, bridges, tunnels, wastewater treatment, and public transportation from the proposed *Mosquito Population Control Program in the Rockaways*.

ALTERNATIVES

The *Mosquito Population Control Program in the Rockaways* involves the application of adulticides to control adult mosquitoes due to concerns about the health and well being of citizens in the Rockaways. This section describes the alternatives for the *Mosquito Population Control Program in the Rockaways.* These alternatives are presented in greater detail in Chapter 3.U, "Alternatives," of the *Mosquito-Borne Disease Control Program*. However, this section addresses the suitability for these alternatives with respect to the *Mosquito Population Control Program in the Rockaways.* These alternatives have limitations and inabilities to reduce significant numbers of adult mosquitoes, which make them inadequate to wholly substitute for the use of adulticides.

The Alternatives are grouped into the following categories: No Action; Biological Control; Alternative Technologies; Unauthorized Programs; Program Alternatives; and OMWM.

No Action

The No Action Alternative describes the future condition if the *Mosquito Population Control Program in the Rockaways* is not implemented and the *Routine Program* continues as the mosquito control program in the Rockaways.

Under this alternative, larvicide application would continue under the *Routine Program*. This action, however, would only control larval populations of mosquitoes. Persistent, biting adult mosquitoes would continue to occur in the Rockaways.

Biological Alternatives

The Biological Control Alternatives would employ biological control measures (e.g., introducing additional organisms—fish, birds, and insects—that consume mosquito larvae or adult mosquitoes) into the environment. In some locales, these methods have had limited success. In the absence of

pesticide use, implementation of these methods may not be adequate to successfully reduce dense populations of mosquitoes, as is needed in the Rockaways.

Introducing fish or amphibians to any water bodies—enclosed or open—in the Rockaways would control only a small portion of mosquito larvae populations. Mosquitoes would continue to proliferate, and adult mosquito populations would continue to exist. The freshwater pockets that can appear in the form of puddles and water in containers cannot be stocked with fish or amphibians to control the breeding of mosquitoes. Thus, this alternative (as a stand-alone measure) would likely fail to reduce adult biting mosquitoes in the Rockaways. The unknown ecological effects of introducing fish into an environment with other living organisms could also disrupt predator-prey relationships.

Introducing other insectivorous organisms is extraordinarily difficult to employ on a short-term notice, and would only control a small portion of mosquito larvae and adult populations. The unknown ecological effects of introducing these organisms into an environment with other living organisms could also disrupt predator-prey relationships. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the density of adult mosquitoes and likely create greater ecological impacts because of the introduction of additional populations of organisms in the environment.

Increasing bird populations would not achieve the goal of reducing adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the high density of adult biting mosquitoes as effectively as the use of adulticides.

The diet of insectivorous bats consists of insects other than mosquitoes. Bats also have the potential to transmit rabies, a virus for which the NYCDOH takes a very conservative approach when dealing with human exposure. Therefore, it is unlikely that the *Mosquito Population Control Program in the Rockaways* would include supplementing the existing Rockaways bat population.

Alternative Technologies

Alternative Technologies include the installation of mechanical devices throughout the Rockaways to catch and kill adult mosquitoes (e.g., Mosquito Magnets™ and bug zappers).

The reliance on Mosquito Magnets™ for mosquito control throughout the Rockaways would be infeasible because these units rely upon carbon dioxide as the means for attracting mosquitoes, and there are a plethora of such sources throughout the Rockaways. Deploying such units on a short-term notice at numerous potential locations throughout the Rockaways would also be impractical, and would only control a small portion of adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the high density of adult mosquitoes in the Rockaways as effectively as the use of adulticides.

As the primary method of control, bug zappers (and alternative technologies in general) are not efficient enough to meet the goals and objectives of the *Mosquito Population Control Program in the Rockaways*. These units require power sources, and studies have shown that mosquitoes are only a small percentage of the creatures killed by such devices. Deploying such units on a short-term notice at numerous potential locations throughout the Rockaways would also be impractical, and would only control a small portion of adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the population of persistent biting adult mosquitoes and settling the health and well being of citizens in the Rockaways.

Unauthorized Programs

The Unauthorized Programs Alternative discusses programs that would either require NYCDOH actions without receiving approvals beforehand, such as applying larvicides in every potential mosquito breeding location in the Rockaways, including private properties, or mandating the installation of window screens for every Rockaways residence.

The limitations of implementing only an increased larviciding program would be the failure to control adult mosquito populations and the necessity of trespassing on private properties. Although this alternative would be impractical to employ, the residents and workers of the Rockaways would likely be exposed to fewer adult mosquitoes under this alternative than under the No Action Alternative. However, even with additional larviciding, adult mosquitoes would continue to emerge in large numbers, maintaining the need to control adult mosquito populations in the Rockaways.

It would be nearly impossible to force installation of window screens in all Rockaways publicly and privately owned homes and apartments. Legislation would have to be adopted to direct and enforce this alternative. This alternative would also not protect people who were outside during the hours when biting mosquitoes are most active. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to be exposed to high densities of biting mosquitoes.

NYCDOH is continuing to pursue approvals for larviciding of areas in Gateway National Park to reduce mosquito generation and the persistent biting of adult mosquitoes, but has not been successful to date. Under this alternative, NYCDOH would apply adulticides in Gateway National Park. If such approvals were gained in the future, NYCDOH would work with the National Parks Service to minimize the potential impacts to non-target species from these actions.

Program Alternatives

Program Alternatives would add, eliminate, or change one or more of the program elements that NYCDOH would not include in the *Mosquito Population Control Program in the Rockaways* at this time (e.g., adulticide applications during daylight periods; no voluntary buffer zones near water bodies; and new USEPA and New York State registered insecticides in the future).

Under this alternative, NYCDOH would monitor the primary species present in the Rockaways area. If at some time in the future the NYCDOH considers that spraying of adulticides should be required for daylight hours, such actions would be subject to environmental review and assessment pursuant to CEQR and SEQRA.

If the elimination of the voluntary buffer zones is recommended in the future, such an action would be subject to environmental review and assessment pursuant to CEQR and SEQRA.

If the NYCDOH modifies the program at some time in the future to include the use of additives beyond those required as a minimum by the product label, this would be subject to environmental review and assessment pursuant to CEQR and SEQRA.

Open Marsh Water Management Alternative

The OMWM Alternative would involve altering wetlands in the Rockaways to provide circulation and flow in these habitats to eliminate potential standing-water mosquito breeding grounds.

The NYCDOH is actively pursuing the implementation of this alternative. It would take several years to accomplish the goals of OMWM and benefit from the execution of this alternative. This alternative would have to be examined on a site-by-site basis to ensure that there are no adverse impacts to

ecosystems from the changes to tidal flow patterns and wetland vegetation. Permits would be required from NYSDEC and COE to perform such activities.

These types of source reduction and enhancement measures would reduce potential sites for mosquito breeding. However, these activities would potentially only reduce mosquito larvae populations, and would not have an effect on identified adult mosquito populations. Although these measures are being actively being pursued by City, State, and Federal agencies, this alternative (as a stand-alone measure) would likely fail to reduce the potential for adult mosquitoes that persistently bite humans. Therefore, it is likely that applications of adulticides would need to continue in congruence with this alternative if adult mosquito populations in the Rockaways are not significantly reduced.

4.J ROCKAWAYS OPEN SPACE

The presence of biting mosquitoes would likely be greater in the future without the Proposed Action. Thus, avoidance of outdoor open spaces during times of mosquito activity is likely to increase in the future without the Proposed Action. The *Mosquito Population Control Program in the Rockaways* is not expected to result in permanent changes to open spaces in the Rockaways. However, the application of adulticides as part of the plan's Mosquito Prevention and Control component may cause some open spaces to be closed to the public during the time period immediately before, during and shortly after population-control activities.

While the adulticiding actions would result in the closure of some parks and other spaces for limited times, the lack of a *Mosquito Population Control Program in the Rockaways* (and the attendant rise in the number of biting mosquitoes) would likely result in similar, if not greater, reductions in use of open spaces during the summer months.

Since population control activities would occur on a limited number of nights during the summer, and since the reduction in use of open spaces would be similar to or less than the reduction that would take place in the No Action condition, the impacts to open space resources would not be considered significant adverse impacts.

4.K ROCKAWAYS CULTURAL RESOURCES

Based on the amount of product applied in a given application and the capability of each of the potential products to break down under sunlight conditions, none of the adulticides are expected to cause damage to any building materials or external building surfaces. Therefore, the *Mosquito Population Control Program in the Rockaways* would not be expected to physically impact any cultural resources in any of the study areas. Furthermore, any reduction to the outdoor components of cultural resources on the Rockaway Peninsula would be temporary in nature—limited to the period of application and potentially the hours immediately before and after application. As such, the activities associated with *Mosquito Population Control Program in the Rockaways* would not result in significant adverse impacts to any cultural resources.

Moreover, since the *Mosquito Population Control Program in the Rockaways* activities would take place above ground and would not penetrate the surface, they would not have the potential to significantly affect subsurface resources, such as archaeological remains.

4.L ROCKAWAYS VISUAL RESOURCES

This section assesses the potential impacts of the *Mosquito Population Control Program in the Rockaways* on visual resources, which are an area's unique or important public view corridors, vistas, or natural or built features. Visual impacts would include the blocking of a significant view or

resource, changes to an urban design feature so that a natural or built visual resource is no longer dominant in an area, or changes to an urban design feature so that the context of a visual resource is altered.

No permanent structures would be created as a result of the population-control activities and the application would occur principally by truck. The only visual changes that would occur would be trucks passing through neighborhoods during periods of application. Therefore, the *Mosquito Population Control Program in the Rockaways* activities would not result in any significant adverse impacts on visual resources.

4.M ROCKAWAYS TRANSPORTATION

The *Mosquito Population Control Program in the Rockaways* would not generate any significant new vehicle trips that would require an impact assessment under the guidelines contained in the *New York City Environmental Quality Review (CEQR) Technical Manual.* Before vehicles would be sent out to a zone targeted for adulticide spraying, the NYCDOH would convene with the applicators to identify bodies of water and sensitive natural resources in the target area.

If applying by truck, all spray systems would be shut off when passing within 100ft of water bodies or the approaches to bridges. When applying adulticides under the *Mosquito Population Control Program in the Rockaways* by truck, applications would not be made on major highways. When traveling down a dead end block, the adulticide spray system would be shut off when the truck is traveling down the block, and turned back on when the truck turns around to depart out of the dead-end block. When applying adulticides in parks under the auspices of NYCDPR, NYCDPR staff would lead the vehicles through such facilities. In cases where there are limits on internal roadways for truck access, all terrain vehicles (ATVs) may be deployed to apply the products.

4.N ROCKAWAYS AIR QUALITY

The Proposed Action would not result in a significant number of new ground or aircraft trips, nor would the action result in any exceedances of PM_{10} air quality standards. Therefore, the proposed *Mosquito Population Control Program in the Rockaways* would not result in exacerbations or new violations of any National or New York State Ambient Air Quality Standards, and thus, the program would be consistent with New York State Implementation Plans.

4.O ROCKAWAYS NOISE

Based on the analyses for the *Mosquito-Borne Disease Control Program*, and the assumption that only trucks would apply adulticides on the Rockaway Peninsula under the *Mosquito Population Control Program in the Rockaways*, the Proposed Action would result in a significant adverse noise impact. Since the function of the police warning announcement is to make the public aware spraying activities and minimize potential direct impacts on the public, the noise impacts from such operations would not be mitigated.

4.P ROCKAWAYS WATERFRONT REVITALIZATION PROGRAM POLICIES

Because the *Mosquito Population Control Program in the Rockaways* would be undertaken within the boundaries of New York City's Coastal Zone, it is therefore subject to a consistency review with the WRP. The WRP, which was approved by and is part of the State's Coastal Zone Management program, consists of 44 statewide policies and 12 policies specific to New York City.

While the *Mosquito Population Control Program in the Rockaways* would be consistent with all applicable policies, the program could have impacts on fish and wildlife habitats and resources. Because of this, the program has been developed to minimize potential significant adverse impacts to these resources while still protecting human health. During adulticide spray events, the *Mosquito Population Control Program in the Rockaways* would maintain a 100-foot buffer around water bodies for truck and aerial application of adulticides to protect and preserve significant coastal fish and wildlife habitats. Transportation and storage of adulticides would be conducted in a manner that would minimize the potential for spills into coastal waters. In the event of a spill mitigation measures have been developed to minimize significant adverse impacts.

4.Q ROCKAWAYS UNAVOIDABLE ADVERSE IMPACTS

All of the active ingredients and certain inert ingredients in the pesticides proposed for the *Mosquito Population Control Program in the Rockaways* have been linked to skin and eye irritation in humans. There would be potential adverse skin and eye irritation impacts to people who are sensitive to the active ingredients and inerts. These adverse effects could occur on workers and residents who are directly exposed to the adulticides, especially due to direct contact near the point of application. While these potential adverse impacts would be reduced by public information announcements (both in the media and by police vehicles escorting ground applications), it is assumed that not all of the population would be able to avoid direct contact with the adulticides. Therefore, this would result in potential unavoidable adverse impacts from skin and eye irritation.

There may be some adverse impacts and loss of non-target insects and other terrestrial arthropods from the all of the active ingredients as a result of the *Mosquito Population Control Program in the Rockaways.* These losses at the individual level for insects are not considered to be significant adverse impacts, but would be unavoidable adverse impacts.

Although not expected to be significant adverse impacts, there would be predicted unavoidable adverse impacts to aquatic life from stormwater runoff from all of the active ingredients.

As a result of the application of malathion under the *Mosquito Population Control Program in the Rockaways*, the water quality standard for malathion is predicted to be exceeded when runoff containing this active ingredient drains into Jamaica Bay. This is considered a potential significant adverse impact of the Proposed Action, and would be an unavoidable adverse impact associated with the application of malathion if rainfall follows the application.

4.R ROCKAWAYS IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There are several resources that would be expended in the operation of the *Mosquito Population Control Program in the Rockaways*. These resources include the consumption of fuel in the form of gas and electricity consumed during operations, and the human effort required to plan and implement the components of the program. They are considered irretrievably committed because their reuse for some other purpose than the project would be highly unlikely.

4.S ROCKAWAYS ENERGY

The proposed the *Mosquito Population Control Program in the Rockaways* is not expected to raise any significant issues related to long-term demands for, or significant impacts on, the Rockaways' or the City's energy system. Depending on the method of application of adulticides (e.g., backpack, all terrain vehicle, or truck), it may require the use of equipment or vehicles to apply the adulticides.

These can either be portable units or vehicles fueled by fossil fuels. Energy consumption associated with the proposed activities would not result in any significant adverse effects on energy fuel resources.

4.T ROCKAWAYS GROWTH-INDUCING ASPECTS

The proposed *Mosquito Population Control Program in the Rockaways* is not expected to alter regional growth patterns, impact residential settlement patterns, affect the growth in employment centers, or to significantly induce development within the Rockaway Peninsula or the City.

4.U ROCKAWAYS ALTERNATIVES

The *Mosquito Population Control Program in the Rockaways* involves the application of adulticides to control adult mosquitoes due to concerns about the health and well being of citizens in the Rockaways. This section describes the alternatives for the *Mosquito Population Control Program in the Rockaways.* These alternatives are presented in greater detail in Chapter 3.U, "Alternatives," of the *Mosquito-Borne Disease Control Program*. However, this section addresses the suitability for these alternatives with respect to the *Mosquito Population Control Program in the Rockaways.* These alternatives have limitations and inabilities to reduce significant numbers of adult mosquitoes, which make them inadequate to wholly substitute for the use of adulticides.

The Alternatives are grouped into the following categories: No Action; Biological Control; Alternative Technologies; Unauthorized Programs; Program Alternatives; and OMWM.

NO ACTION

The No Action Alternative describes the future condition if the *Mosquito Population Control Program in the Rockaways* is not implemented and the *Routine Program* continues as the mosquito control program in the Rockaways.

Under this alternative, larvicide application would continue under the *Routine Program*. This action, however, would only control larval populations of mosquitoes. Persistent biting of adult mosquitoes would continue to occur in the Rockaways.

BIOLOGICAL ALTERNATIVES

The Biological Control Alternatives would employ biological control measures (e.g., introducing additional organisms—fish, birds, and insects—that consume mosquito larvae or adult mosquitoes) into the environment. In some locales, these methods have had limited success. In the absence of pesticide use, implementation of these methods may not be adequate to successfully reduce dense populations of mosquitoes, as is needed in the Rockaways.

Introducing fish or amphibians to any water bodies—enclosed or open—in the Rockaways would control only a small portion of mosquito larvae populations. Mosquitoes would continue to proliferate, and adult mosquito populations would continue to exist. The freshwater pockets that can appear in the form of puddles and water in containers cannot be stocked with fish or amphibians to control the breeding of mosquitoes. Thus, this alternative (as a stand-alone measure) would likely fail to reduce adult biting mosquitoes in the Rockaways. The unknown ecological effects of introducing fish into an environment with other living organisms could also disrupt predator-prey relationships.

Introducing other insectivorous organisms is extraordinarily difficult to employ on a short-term notice, and would only control a small portion of mosquito larvae and adult populations. The unknown ecological effects of introducing these organisms into an environment with other living

organisms could also disrupt predator-prey relationships. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the density of adult mosquitoes and likely create greater ecological impacts because of the introduction of additional populations of organisms in the environment.

Increasing bird populations would not achieve the goal of reducing adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the high density of adult biting mosquitoes as effectively as the use of adulticides.

The diet of insectivorous bats consists of insects other than mosquitoes. Bats also have the potential to transmit rabies, a virus for which the NYCDOH takes a very conservative approach when dealing with human exposure. Therefore, it is unlikely that the proposed program would include supplementing the existing Rockaways bat population.

ALTERNATIVE TECHNOLOGIES

Alternative Technologies include the installation of mechanical devices throughout the Rockaways to catch and kill adult mosquitoes (e.g., Mosquito Magnets™ and bug zappers).

The reliance on Mosquito Magnets™ for mosquito control throughout the Rockaways would be infeasible because these units rely upon carbon dioxide as the means for attracting mosquitoes, and there are a plethora of such sources throughout the Rockaways. Deploying such units on a short-term notice at numerous potential locations throughout the Rockaways would also be impractical, and would only control a small portion of adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the high density of adult mosquitoes in the Rockaways as effectively as the use of adulticides.

As the primary method of control, bug zappers (and alternative technologies in general) are not efficient enough to meet the goals and objectives of the *Mosquito Population Control Program in the Rockaways*. These units require power sources, and studies have shown that mosquitoes are only a small percentage of the creatures killed by such devices. Deploying such units on a short-term notice at numerous potential locations throughout the Rockaways would also be impractical, and would only control a small portion of adult mosquito populations. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the population of persistent biting adult mosquitoes and settling the health and well being of citizens in the Rockaways.

UNAUTHORIZED PROGRAMS

The Unauthorized Programs Alternative includes actions by NYCDOH without obtaining the required approvals beforehand (such as applying larvicides in every potential mosquito breeding location in the Rockaways, including private properties, or mandating the installation of window screens for every Rockaways residence).

The limitations of implementing only an increased larviciding program would be the failure to control adult mosquito populations and the necessity of trespassing on private properties. Although this alternative would be impractical to employ, the residents and workers of the Rockaways would likely be exposed to fewer adult mosquitoes under this alternative than under the No Action Alternative. However, even with additional larviciding, adult mosquitoes would continue to emerge in large numbers, maintaining the need to control adult mosquito populations in the Rockaways.

It would be nearly impossible to force installation of window screens in all Rockaways publicly and privately owned homes and apartments. Legislation would have to be adopted to direct and enforce

this alternative. This alternative would also not protect people who were outside during the hours when biting mosquitoes are most active. Thus, this alternative (as a stand-alone measure) would likely fail to reduce the potential for humans to be exposed to high densities of biting mosquitoes.

NYCDOH is continuing to pursue approvals for larviciding of areas in Gateway National Park to reduce mosquito generation and the persistent biting of adult mosquitoes, but has not been successful to date. Under this alternative, NYCDOH would apply adulticides in Gateway National Park. If such approvals were gained in the future, NYCDOH would work with the National Parks Service to minimize the potential impacts to non-target species from these actions.

PROGRAM ALTERNATIVES

Program Alternatives would add, eliminate, or change one or more of the program elements that NYCDOH would not include in the *Mosquito Population Control Program in the Rockaways* at this time (e.g., adulticide applications during daylight periods; no voluntary buffer zones near water bodies; and new USEPA and New York State registered insecticides in the future).

Under this alternative, NYCDOH would monitor the primary species present in the Rockaways area. If at some time in the future the NYCDOH considers that spraying of adulticides should be required for daylight hours, such actions would be subject to environmental review and assessment pursuant to CEQR and SEQRA.

If the elimination of the voluntary buffer zones is recommended in the future, such an action would be subject to environmental review and assessment pursuant to CEQR and SEQRA.

If the NYCDOH modifies the program at some time in the future to include the use of additives beyond those required as a minimum by the product label, this would be subject to environmental review and assessment pursuant to CEQR and SEQRA.

OPEN MARSH WATER MANAGEMENT ALTERNATIVE

The OMWM Alternative would involve altering wetlands in the Rockaways to provide circulation and flow in these habitats to eliminate potential standing-water mosquito breeding grounds.

The NYCDOH is actively pursuing the implementation of this alternative. It would take several years to accomplish the goals of OMWM and benefit from the execution of this alternative. This alternative would have to be examined on a site-by-site basis to ensure that there are no adverse impacts to ecosystems from the changes to tidal flow patterns and wetland vegetation. Permits would be required from NYSDEC and COE to perform such activities.

These types of source reduction and enhancement measures would reduce potential sites for mosquito breeding. However, these activities would potentially only reduce mosquito larvae populations, and would not have an effect on identified adult mosquito populations. Although these measures are being actively being pursued by City, State, and Federal agencies, this alternative (as a stand-alone measure) would likely fail to reduce the potential for adult mosquitoes that persistently bite humans. Therefore, it is likely that applications of adulticides would need to continue in congruence with this alternative if adult mosquito populations in the Rockaways are not significantly reduced.

4.V ROCKAWAYS MITIGATION

Potential exceedances of the malathion water quality standard were predicted if there is a rainfall after an application of malathion. The estimated exposure concentration in the waters of Jamaica Bay, were calculated to be slightly greater than the applicable malathion water quality standard. While these malathion exposure concentrations would not result in HQs that would result in significant adverse

impacts on aquatic life in Jamaica Bay, the predicted violations of the malathion water quality standard are considered to be significant adverse impacts.

The estimates of malathion concentrations in Jamaica Bay are considered to be conservative estimates. If malathion were applied under this program, the City would conduct pre- and post-application monitoring (including post-application monitoring after rainfall for up to one week after the application of malathion) to determine if the predicted impacts would occur. If the measured levels of malathion are as large as those estimated for the runoff in this EIS, these water quality impacts would occur and remain unmitigated. In the future, use of smaller droplet sizes could substantially reduce the deposition of malathion onto the ground, thus reducing the potential runoff into Jamaica Bay

Potential significant adverse impacts from the *Mosquito Population Control Program in the Rockaway* were predicted from the proposed truck application of adulticides. Like in the proposed *Mosquito-Borne Disease Control Program*, each truck would be escorted by a police vehicle with an announcement to warn people about the spraying. This warning vehicle's purpose is to produce announcements that the public can hear, and, therefore, it will produce short-term noise levels that are noticeable and may be considered to be intrusive. Noise from the police warning vehicle and an announcement would produce an $L_{eq(1)}$ noise level of at least approximately 50 dBA at 25 feet. Together, the warning police vehicle announcement and the spray truck would produce an $L_{eq(1)}$ noise level of approximately 51.2 dBA at 25 feet. Therefore, at the quietest of locations, with the Proposed Action, nighttime $L_{eq(1)}$ noise levels would increase from approximately 48 dBA to approximately 53 dBA. This change in noise level, the increase in $L_{eq(1)}$ noise levels would be approximately 5 dBA, would be a readily noticeable change in noise levels, which would be a significant adverse impact. More importantly, when the police warning vehicle with the blow horn and the spray truck pass, both in quiet neighborhoods and even in neighborhoods that are not particularly quiet, they will produce short-term passby noise levels that are likely to be noticeable and intrusive to residents. Since the function of the police warning announcement is to make the public aware and minimize potential direct impacts on the public, the noise impacts from such operations would not be mitigated.

5. CUMULATIVE IMPACTS FROM THE TWO PROPOSED ACTIONS

NYCDOH is proposing both the *Mosquito-Borne Disease Control Program* and the *Mosquito Population Control Program in the Rockaways* under the *Adult Mosquito Control Programs*. Based on the results of the environmental assessments for each of these programs, and the planned operation of the two programs, the potential cumulative impacts from the Proposed Action were evaluated.

The analyses for the *Mosquito-Borne Disease Control Program,* conservatively evaluated the potential City-wide effects from 10 spray events over a two month period, with some relatively short time periods between applications. The analyses for the *Mosquito Population Control Program in the Rockaways* evaluated the potential effects in and adjacent to the Rockaways Peninsula from 6 spray events over a 3-month period from this Proposed Action

In the event that NYCDOH surveillance of mosquito-borne pathogens indicates that there is a threat to public health from mosquitoes on the Rockaway Peninsula, considerations will be given to the most recent applications of adulticides on the Peninsula under the *Mosquito Population Control Program in the Rockaways*. If adulticide applications have occurred on the Peninsula in the time period between surveillance detection of the public threat from mosquito-borne viruses, NYCDOH

will continue surveillance of the adult mosquito population until the increase in mosquito population again presents a threat to human health from mosquito-borne pathogens.

There would be no anticipated cumulative significant adverse impacts on land use, community facilities, public policy and zoning, public health, water supply, infrastructure, hazardous materials, socioeconomic conditions, open space, cultural resources, visual resources, transportation, air quality, waterfront revitalization program policies, irreversible and irretrievable commitment of resources, energy, or growth inducing aspects from the Proposed Action.

Many of the alternatives for each program are similar. In the case of a public health threat indicated via surveillance for the *Mosquito-Borne Disease Control Program*, these alternative methods of control will not wholly substitute for an adulticiding plan and the significant reduction of adult mosquitoes. In general, these alternatives have limitations and inabilities to reduce significant numbers of adult mosquitoes, which make them inadequate to wholly substitute for the use of adulticides. Some of the alternatives may be used in addition to the application of larvicides and adulticides to supplement the effectiveness of controlling adult mosquito populations. For those alternatives that would potentially result in significant adverse impacts, should NYCDOH elect to employ them in the future, an environmental review of the potential cumulative impacts under both programs would have to be performed before implementation of such alternatives.

PREDICTED CUMULATIVE ADVERSE IMPACTS

NATURAL RESOURCES

Both programs are expected to result in potential adverse affects on non-target arthropods (particularly nighttime flying organisms). However, these affects are not predicted to be significant adverse impacts.

Potential significant adverse affects from both programs are expected to occur on individuals of aquatic species immediately near the discharge points of stormwater outfalls if it rains after an application of adulticides. With the projected maximum number of adulticide applications from either program— up to10 in the same area over a 2 to 3 month period, these short-term losses in localized areas near the discharge of runoff after a rain event are not expected to significantly reduce individuals at the population level. It is expected that individuals of the same species would repopulate areas which are affected by any of these localized losses.

Based on Tier I and II risk assessment calculations, the potential concentrations of malathion (due to runoff if a storm event occurs after application of malathion over a large land coverage that drains to Jamaica Bay) could be well above estimated no effect levels for crustaceans in Jamaica Bay. The analyses performed in this study assumed that a large coverage of land in Brooklyn and Queens would have malathion applied, and rainfall after the application would result in a large runoff of this active ingredient to Jamaica Bay. Given that Jamaica Bay can receive such large discharges of runoff and has limited mixing with the Atlantic Ocean, the net result is that calculated malathion concentrations in the water were well above estimated no effect levels for crustaceans. Crustaceans in Jamaica Bay are largely comprised of barnacles, shrimp, and crabs. Even though the concentrations of malathion would not persist for a long time in the bay, given that the calculated concentrations of malathion would be over a large area with levels well above the calculated no effect level, it was determined that the application of malathion and runoff from rainfall would result in potential significant adverse impacts on these organisms in Jamaica Bay. Other water bodies around New York Harbor would not receive such concentrated loadings of malathion and mix into other larger

water bodies that have much higher volumes of water dilution, and therefore, the predicted significant adverse impacts to aquatic life would be limited to Jamaica Bay.

As part of the Proposed Action, NYCDOH will continue to monitor water bodies before and after any adulticide applications. If malathion is selected in the future for Jamaica Bay, these impacts may be lessened once completion of the CSO holding tank at Paerdegat Basin is fully constructed (which will reduce the direct discharges into the bay after rainfall). In addition, NYCDOH may elect to apply the active ingredients in smaller droplet sizes (e.g., average mean diameter less than 30 microns), because studies in other parts of the country have shown that smaller droplet sizes substantially reduce the amount of the active ingredient that reaches the ground, and therefore, less would runoff if a rainfall event would occur after the application.

WATER QUALITY

The only surface-water resource with the potential to have cumulative water quality effects from deposition of the active ingredients in drift during ground application or stormwater discharge following a spray event from the two programs would be Jamaica Bay. No significant adverse impacts to water quality are expected from the *Mosquito-Borne Disease Control Program* or the *Mosquito Population Control Program in the Rockaways* with the exception of the active ingredient malathion. Malathion is the only active ingredient with a State water quality standard. This standard applies to most of the surface water classes in and around the City (0.1 mg/L). The estimated exposure concentration in Jamaica Bay calculated from the *Mosquito-Borne Disease Control Program* indicated that the ground application of malathion has the potential to result in concentrations in Jamaica Bay waters that exceed the applicable water quality standard. The estimated exposure concentration in Jamaica Bay for the *Mosquito Population Control Program in the Rockaways* also resulted in a potential exceedance of the State water quality standard in Jamaica Bay from rainfall after a malathion application on the complete Rockaway Peninsula.

The volume of stormwater runoff containing malathion from the Rockaways (under the *Mosquito Population Control Program in the Rockaways)* would be much less than that calculated for the storm water discharged from the remaining areas of the City draining to the Bay (under the *Mosquito-Borne Disease Control Program*). Therefore, should both programs apply malathion to the respective areas concurrently, the predicted cumulative impact of the two proposed programs, should be equivalent to those projected for the Citywide *Mosquito-Borne Disease Control Program*, and there would be a predicted potential significant impacts on the water quality standard in Jamaica Bay from the application of malathion.

NOISE

Both programs are expected to result in significant adverse noise impacts from police escort/truck applications (and aircraft operations for the *Mosquito-Borne Disease Control Program*). Each truck would be escorted by police vehicle with an announcement to warn people about the spraying. This warning vehicle's purpose is to produce announcements that the public can hear, and, therefore, it will produce short-term noise levels that are noticeable and may be considered to be intrusive. Since the function of the police warning announcement is to make the public aware and minimize potential direct impacts on the public, the noise impacts from such operations would not be mitigated. These noise impacts from truck applications are expected to be localized, and the cumulative impacts from both programs would be the same as that from each individual program. These impacts would remain unmitigated and would remain as unavoidable adverse impacts. The noise impact from the truck and

police warning for the truck applications would be localized, and the cumulative adverse impact from truck applications from both programs would be expected to be the same as that for each program.

UNAVOIDABLE ADVERSE IMPACTS

Potential unavoidable adverse impacts—either adverse effects or significant adverse impacts—that are expected as a result of the Proposed Action include:

- Significant adverse impacts would occur on crustaceans in Jamaica Bay and similar inlet bays with stormwater outfalls and limited tidal flushing (e.g., Little Neck Bay in Northern Queens) if it rains after the application of malathion over a large land area under the *Mosquito-Borne Disease Control Program,* but impacts from malathion on these waterbodies under the *Mosquito Population Control Program in the Rockaways* would be significantly less. The cumulative unavoidable adverse impact would be equivalent to the predicted *Mosquito-Borne Disease Control Program* impacts.
- Short-term losses of aquatic life from stormwater runoff of active ingredients of adulticides near the points of discharge for all active ingredients. These losses are predicted in localized areas during rain events immediately following application of adulticides over large land areas that drain into inlet bays (e.g., Jamaica Bay, Little Neck Bay).
- The loss of individuals from the application of adulticides in some species of terrestrial arthropods (i.e., nighttime flying insects) directly exposed to these ingredients during the application of products.
- Potential significant adverse impacts are expected from the predicted exceedence of malathion water quality standards from the application of malathion from both programs, due to runoff.

Noise from either low flying aircraft (only for the *Mosquito-Borne Disease Control Program*) or truck application of adulticides with police warning announcements in front of the trucks would be a significant adverse impact. ✦