Duka Environmental Services Ltd.

REGIONAL DISTRICT OF CENTRAL OKANAGAN

Integrated Pest Management Program

Nuisance and Vector Mosquito Surveillance and Control
2024 Summary Report

A backyard pond and prolific mosquito habitat

Prepared for
The Regional District of Central Okanagan
Kelowna, British Columbia

Prepared by
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03 December 2024
File # 1624

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EXECUTIVE SUMMARY

Regional District of Central Okanagan
2024 Nuisance and Vector Mosquito Surveillance and Control Program

The Regional District of Central Okanagan (RDCO) has provided residents, workers and visitors with mosquito surveillance and control services for over thirty years. Program services are provided to the City of Kelowna, the District of Lake Country, District of Peachland, Westbank First Nation and defined areas in the City of West Kelowna and RDCO Central Okanagan East Electoral Area.

The RDCO, centered around the City of Kelowna, has significant recreational and environmental value, providing residents and visitors with many outdoor summer activities and employment. Walking, cycling, camping, horseback riding, bird watching, biking, boating, sunbathing, beaches, golfing, wine tasting and tours are just a few of these activities. Adult mosquito annoyance can often conflict with these activities. Besides the negative impacts on the lifestyle of residents, there can be considerable economic impact from mosquito annoyance on businesses and outdoor workers.

The goal of the annual mosquito control program is to reduce the potential for widespread adult mosquito annoyance and possibility of mosquito-borne disease, for the benefit of residents, workers, and area visitors. This is achieved by the suppression of larval mosquito populations using an integrated pest management (IPM) approach to their timely surveillance, prevention, and control. Where possible, and appropriate, suggestions are recommended that may reduce larval habitat, and which will enhance, or conserve, natural mosquito predators. Where required, larval mosquito populations were controlled using the bio-rational larvicide product VectoBac® 200G (*Bacillus thuringiensis* var. *israelensis*, *Serotype H-14 Strain AM65-52*; PCP #18158) and VectoLex (*Bacillus sphaericus*; PCP #28008, #28009).

Larval development habitats within the RDCO program include sloughs, back channels and low-lying fields, forested areas and undeveloped areas located along Mission Creek and adjacent to numerous small lakes. Snowmelt and precipitation run-off increases creek and lake levels to cause flooding and seepage water accumulations in adjacent areas. Natural, permanent, temporary, seepage and spring-fed ponds and marshes are also located throughout the control programs boundaries. Man-made display, landscape and settling ponds, drainage and roadside ditches, depressions in farm fields and in undeveloped or rural properties, golf courses etc., also provide potential larval mosquito development habitat. Some 300+ development sites have been identified for routine surveillance and possible treatment within the defined boundaries of the control program.

In addition to natural and man-made waterbodies, containers including buckets, unused fountains and pools, livestock watering troughs, uncovered boats and equipment can all hold water to create a potential mosquito development habitat. These are typically found when responding to mosquito annoyance reports. When encountered they are either emptied or instructions provided to reduce or eliminate their potential as a source of mosquitos. Roadside catch basins are the most widespread

larval development habitat within the RDCO and participating communities. With over 20,000 located along public roadways and parking areas, they provide a potential source for adult mosquitos in residential, commercial, recreational, and industrial areas.

Public education initiatives included routine and regular radio, television, and website advertisements, as well as social media postings. These outreach activities helped residents understand that the control program can only suppress mosquito populations, not eradicate them, and that some adult mosquito annoyance may still occur. The annual used tire-round-up occurred again this year on 07 September in partnership with Tire Stewardship BC, resulting in more than 1400 old and used tires being recycled.

Interactions with business operators or property owners and residents were accomplished through telephone conversations, emails, or in person while on site. Where required, and when property owners, or managers were unavailable or not home, doorknob hangers and notes were left behind by *Duka Ltd.* detailing observations and activities completed, or required, at the property for the purposes of mosquito surveillance and control.

Snowpack survey data collected during the period 01 January to 15 June 2024 indicated a below average accumulation of snowfall in local mountains. Snowpack measurements for the Okanagan snow basin peaked on 01 March (80% of normal) and declined to 49% of normal by 15 May.

Overall weather conditions for the Kelowna area during 2024 could be considered "warmer and wetter" compared with the 2019-2023 averages. April to August were 0.7^{o}C warmer on average relative to the 5-year mean and monthly totals precipitation were about 56% higher than the five-year mean and 29% more than the 10 year mean (2014-2024).

A total of 30 different mosquito species were collected as either larvae or adults during 2024. Of these, some 42% (11 species) have been identified by the BC Centre for Disease Control as potential vectors of West Nile virus, and six of these; *Aedes dorsalis, Aedes vexans, Culiseta inornata, Culiseta incidens, Culex pipiens* and *Culex tarsalis* are listed as competent (++) to highly competent (++++) vectors.

A total of 661.22 kilograms of VectoBac 200G were applied to a total area of 87.058 hectares of active larval mosquito development habitat located throughout the RDCO, City of Kelowna and the West Bank First Nations. Some 219 sites were treated on a total of 994 separate occasions. In addition, a further 0.382 ha of habitat, at 27 individual sites, were treated on 31 occasions with 2.87 kg of VectoLex WSP and VectoLex CG. A total of 24,225 water-holding catch basins located throughout participating communities were treated with VectoLex WSP and CG during two treatment campaigns in 2024.

All applications were completed under the auspices of the BC Ministry of Environment-accepted RDCO, Pest Management Plan # 142-0030-21/26 for Mosquito Control. Year-end program reporting; the *Pesticide Use Follow-up Report* and the *Annual Report for Confirmation Holders* required for the PMP will be completed by *Duka Ltd.* and submitted to the BCMOE on behalf of the RDCO.

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1.0 INTRODUCTION

Duka Environmental Services Ltd. (*Duka Ltd.*), an environmental services firm with extensive experience in integrated pest management, and a specialization in mosquito and biting fly surveillance and population of management are retained were retained by the Regional District of Central Okanagan (RDCO) to coordinate the management and delivery of an effective nuisance and vector mosquito surveillance and control program.

Mosquito surveillance and control services were provided to residential and rural property owners, farmers, businesses, parks, campgrounds, golf courses and other outdoor recreational and tourist facilities. The goal of the annual larval mosquito surveillance and control program is to limit the potential for widespread adult mosquito annoyance, and possibility of mosquito-borne diseases, for the benefit of residents, businesses, workers, and visitors to the RDCO, Kelowna, Peachland and area.

The methodologies and procedures employed for this mosquito surveillance and control program are a hybrid of the most current approaches and standard techniques. Developed by *Duka Ltd.* over some thirty-five operational seasons, and through collaboration with mosquito and vector control professionals worldwide, it has been carefully, and specifically, adapted for the unique conditions of the local program area. Predictive indices for larval mosquito development onset and distributions use winter snowpack, local lake and creek or river levels, precipitation totals and monthly mean temperatures. These indices have enabled *Duka Ltd.* to develop an adaptive approach to effective, efficient, and timely mosquito population surveillance, management and forecasting of larval development onset and distributions. This approach is a model of environmental compatibility and sustainable operations which will suppress local mosquito populations.

A public education and information strategy, mosquito population surveillance, monitoring and control methods are described in the *Regional District of Central Okanagan Mosquito Control Pest Management Plan*, PMP # 142-0030-21/26. The procedures and methodologies employed for this program support the principles of Integrated Pest Management (IPM) and include physical site reduction or modification, the conservation and enhancement of natural predator populations and habitats, and the use of biological, larval control products. Where required, and when other solutions are impractical, or won't effectively reduce mosquito development, the bio-rational larvicide products VectoBac® 200G (*Bacillus thuringiensis* var. *israelensis,* PCP #18158) and VectoLex® CG and WSP (Bacillus sphaericus, PCP # 28008, 28009) are used.

All annual government regulatory agency conditions, notifications and reporting of operations are completed by *Duka Ltd*., on behalf of the RDCO, and as required by the PMP and the applicable regulations and legislation.

2.0 PUBLIC EDUCATION AND INFORMATION

Public input is invaluable to any community function, and it is a key component of all successful, pro-active mosquito control programs. The annual mosquito control program is well known and supported by the community. It has provided mosquito surveillance, monitoring and larval control services for the benefit of residents, businesses, workers, and visitors for over 30 years. Throughout this time, media such as local newspaper, radio, and television interviews, website advertisements, program brochures and posters have provided the public with regular and frequent information on mosquitos, program operations and access to services. Residents, business operators and other stakeholders are encouraged through these media to contact RDCO, or *Duka Ltd.* offices directly, to report potential mosquito development habitat and adult mosquito annoyance.

All requests for service, or for more program information are initially followed-up through telephone or email contact, as requested. Where indicated, *Duka Ltd.* field personnel completed on-site inspections, often with property residents, to locate and review potential larval mosquito habitats (waterbodies). In addition to providing residents with information on how they can reduce larval development and annoyance around their properties, education initiatives help residents understand that the control program can only suppress mosquito populations, not eradicate them, and that some mosquito annoyance may be anticipated at certain locations, times of day and during some years.

All public education materials provided interested individuals with telephone, email (duka@telus.net) and website contact addresses for *Duka Ltd*. (www.duka.consulting) and the RDCO (www.rdco.com). Information on mosquito development and control, or for links to other informative websites and contact information for Provincial, Federal and Environment, or Health offices were available through *Duka Ltd.* Property owners are encouraged to reduce or eliminate standing water on their properties and to support natural predators by installing bird and bat houses. Window screens, repellents, and adult mosquito collection devices such as Mosquito Magnets™ can contribute to reduced adult mosquito annoyance.

- ***Public Information Booths - Tire Roundup***

Duka Ltd. program technicians and biologists, along with Tire Stewardship BC and Western Rubber Products (tire recycler) personnel staffed an informational booth for public outreach at the annual used-tire drop-off in early September 2024. This gave the public an opportunity to learn about mosquito biology, how to reduce larval development and adult mosquito nuisance around their properties and the use of recycled tires in truck bed liners, soft surfaces around pools, walkways and outdoor adventure/climbing equipment for children.

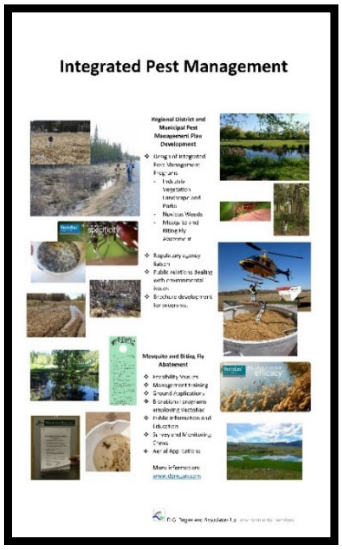
- ***Council, Committee Reports and Meetings***

The RDCO Environmental Services Department, Engineering Technologist, the RDCO Communications and Intergovernmental Affairs Coordinator, and Supervisor of Utility Services were each provided with regular, monthly, written (email) program updates throughout the 2024 operational season. Quarterly summaries of program operations were also provided throughout the year.

In addition to written reports and program updates, regular contact was maintained with these individuals through on-site personal meetings and regular telephone, text message and e-mail communications. *Duka Ltd.* office staff also maintained regular contact with RDCO office reception personnel during the season to receive any service requests or reports of adult mosquito annoyance from the general public.

- ***Informational Posters***

Laminated, informational posters (11" x 17") were again available to local golf courses and interested businesses for posting in locker, change rooms, lunchrooms or on bulletin boards. These posters contained information on mosquito life cycles, program operations and practical suggestions for how the reader could reduce, or eliminate, larval development habitat around their property and the potential for adult mosquito annoyance.



- ***Newspaper and Radio Interviews***

The RDCO Communications and Intergovernmental Affairs Officer coordinated all print, radio, social media (Facebook, Twitter) and web-based public education outreach for the 2024 Nuisance and Vector Mosquito Surveillance and Control Program. Regular, and frequent, advertisements were placed on Castanet.net, in several local newspapers and radio stations. Media releases and Public Service

Announcements were also routinely aired on SHAW Central Okanagan and cable TV channels. *Duka Ltd.* managers and field personnel also provided local newspapers and radio and television stations with interviews during the summer season.

News media articles and advertisements provided updates on the status of local mosquito populations and provided useful information on program operations, product safety and actions residents could undertake to reduce mosquito habitat and annoyance around their properties. Program access and contact information (telephone, email, website addresses for *Duka Ltd*.) were also provided as part of every interview and article.

- ***Doorknob Message Hangers***

"*Sorry We Missed You!"* doorknob message hangers were left by *Duka Ltd.* technicians and biologists at homes and properties when residents, property owners or business managers weren't available during initial site visits or when responding to a request for service. These cards contained a brief summary of the property inspection, field staff observations or actions, and contact information for further follow-up.

These hangers provided a "closed-loop communication" with residents and business operators about what was done, or what needed to be done, in response to a service request or as a result of field staff observations. These hangers typically result in some 5-10 return telephone calls by property residents to confirm their desire for program participation and to provide property access procedures, including gate keys, codes, or dog names, if required.

- ***Informational Brochures***

Informational brochures provided by the RDCO were distributed by *Duka Ltd.* personnel to interested members of the public, residents and business or facility operators during property inspections and while staffing any public education booths. These brochures summarized program operations, mosquito biology, tips for reducing larval mosquito habitat and adult annoyance. They also provided telephone, email, website, Facebook, and Twitter contact information for the RDCO.

Duka Ltd. also supplied field personnel with "*Your Mosquito Surveillance and Control Program*" informational pamphlets. This pamphlet explains basic mosquito biology, facts about control, and practical steps individuals can take to eliminate or reduce larval development habitat and annoyance around their properties. Often left with doorknob hangers these also provided contact information (email, telephone) and website address for *Duka Ltd.* Additional, public health information and VectoBac 200G (*Bacillus thuringiensis* var. *israelensis*) and VectoLex (*Bacillus sphaericus*) product specific brochures and pamphlets were also available through *Duka Ltd.* and on-line through *www.valentbiosciences.com.*

- ***Social Media (Facebook, X)***

Duka Ltd. maintains a Facebook page (@DukaEnvironmentalServices) allowing us to further engage with the public by the posting of service announcements or observations, friendly reminders to empty containers of standing water, interesting news items and articles, and public health announcements as it relates to mosquitos and disease (i.e. West Nile virus, Zika).

The RDCO also maintains a presence on social media (Facebook and X) and provides routine updates on mosquito control operations, program status and how to access services.

- ***Websites and Email***

All public education materials (advertisements, pamphlets, etc.) provided email (info@dukaes.com) and website contact addresses for Duka Ltd. (www.dukaenvironmental.com) and the RDCO (rdco.com) Detailed information on mosquito development and control, and links to other websites and contact information for Provincial, Federal and Environment, or Health offices were also available.

The public could also report adult mosquito annoyance and potential larval development sites (a waterbody) directly to *Duka Ltd.* using the "*Mosquito Service Request Form*". This form allows residents and business owners to provide details on their properties, potential sites and to request a follow-up response or inspection. The form also allows for the attachment of pictures and/or maps.

- ***Public Communications and Interaction***

In addition to encouraging the public through items such as brochures, door hangers, radio and newspaper articles, interviews, and social media to access the program through RDCO offices, *Duka Ltd*. maintains a toll free, 1-800-681-3472 twenty-four-hour phone line with voicemail. Staffed during routine office hours, the public can contact office personnel to discuss their concerns directly and/or leave a message for the program biologist/technician. Our policy is to respond to public inquiries as soon as possible, typically within hours, and unless it is a weekend, within 24-36 hours.

Typically, as part of initial program start-up or response to service requests, field personnel would knock on the doors of property owners, residents, or business operators with known development sites to introduce themselves and confirm participation in the annual control program. When personal interactions were required to access a property or for the purpose of conversation, *Duka Ltd.* personnel respected any request for continued use of personal protective equipment (PPE), including masks and appropriate distancing as required by COVID 19 protocols.

Field staff wear hi-visibility vests, rubber boots, lanyards with their identification, carry dippers, buckets and their sampling gear making them recognizable to most individuals as the "mosquito control guy or girl". Staff would give, and receive, an "affirmative hand wave" or "thumbs up" from residents and business operators when they were encountered, and if no one was observed, or answered the door, a doorknob hanger or brief note would be left. These summarized what had been done and provided residents and businesses with follow-up contact details for *Duka Ltd.* personnel or more information.

A total of 34 contacts were received by telephone, email, or through the *Duka Ltd.* website reporting form between 17 March and 31 July 2024. Fifteen (61%) of these contacts were to report adult mosquito nuisance. Fourteen calls were to report potential larval development habitat (ponds, ditches) and 6 calls were for more program information or to confirm participation in the program. A summary of service requests received by area is presented in Chart 1 below.

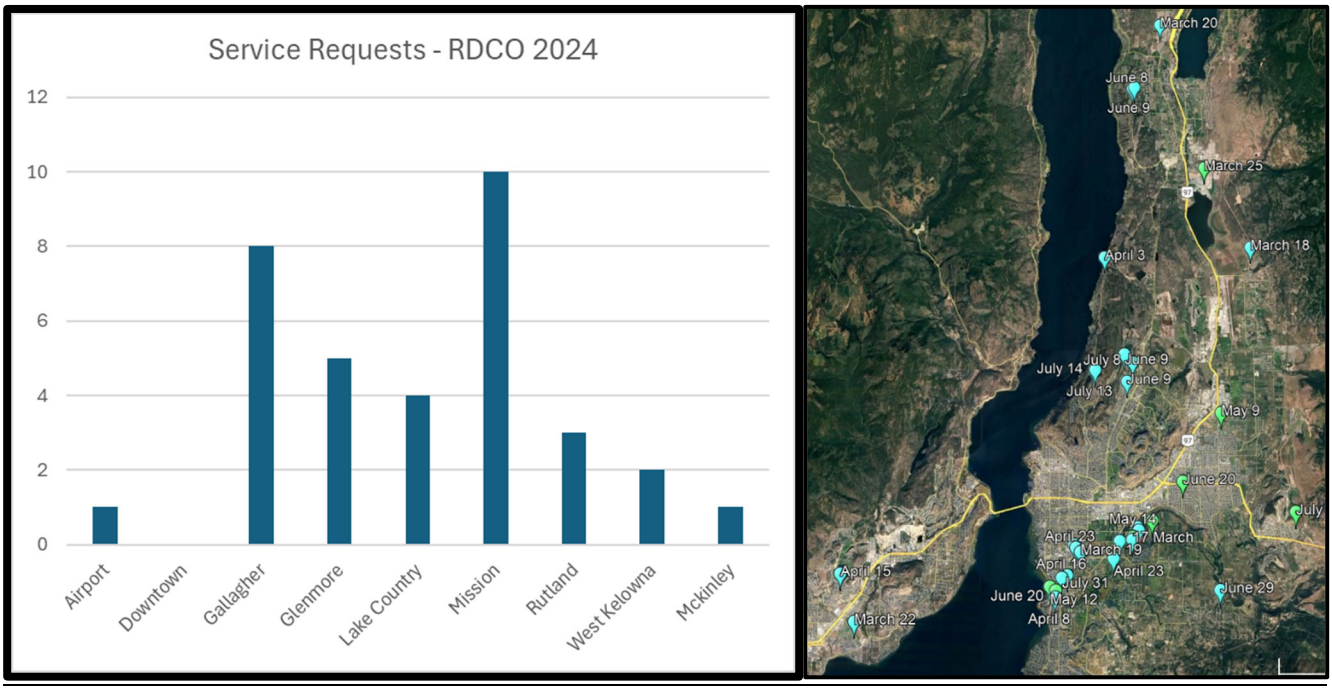


Chart 1: Service Request Summary, by Neighbourhood, 17 March – 31 July 2024.

Field personnel maintained regular contact with maintenance and pro-shop staff at the various golf courses throughout the 2024 season. Regular site visits provided course operators with updates on program operations and allowed field biologists and technicians to solicit input from patrons and staff about any observations of adult mosquitos. Similar conversations with RDCO or City of Kelowna public works personnel encountered at parks and sports fields also provided field staff with useful input and feedback on potential larval mosquito sources and observations of adult mosquito activity.

The highly visible nature of the program with regular an frequents news and social media advertisements, field biologists/technicians working along roadsides, in farm fields, sports fields, parks, campgrounds and local golf courses ensured that residents and area visitors were very familiar with the annual program. The general public, property owners, businesses and local facility operators and managers were all very helpful by providing consent and unhindered access for the purposes of surveying, monitoring and control. With gate keys for many properties and facilities, *Duka Ltd.* personnel could enter and leave these areas as required for timely surveying and control.

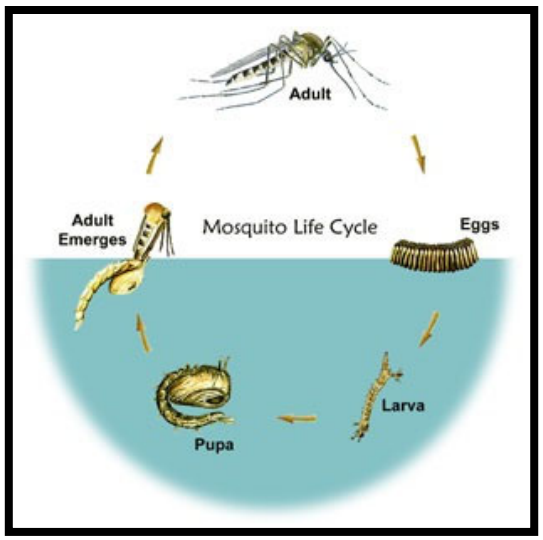
The large majority of residents, business operators and visitors who interacted with *Duka Ltd* field personnel this season reported zero, or very short-lived adult mosquito annoyance this season.

3.0 ENVIRONMENTAL CONDITIONS AND MOSQUITO POPULATIONS

The key to successful mosquito control (population management) and a reduction in adult mosquito nuisance populations is through the early detection and timely control of larval development. Regular surveying and monitoring of potential mosquito development sites, typically beginning in mid to late April of each season, ensures that larval development is identified and treated.

3.1 Mosquito Biology and Public Health

All mosquitoes require water for larval development. Larvae must go through four stages or instars (1st, 2nd, 3rd and 4th), each bigger than the previous, before developing into pupae. Pupae undergo complete metamorphosis and emerge as winged, terrestrial adults. This process can occur in as little as 5-7 days, although typically requires 7-14 days, depending on temperatures.



Adult mosquitos feed on plant juices and it is only the female that requires a blood meal to complete the development of her eggs. Adult, female mosquitoes will typically fly less than 1 – 2km in search of a blood meal although distances of +5 km are not uncommon. They have even been found 30km from their origin and at heights of 10,000 meters. While these are the extreme, and rare distances, the impact of winds on mosquito dispersal can be significant.

Mosquitos are best known as vectors of 'tropical' diseases such as malaria and yellow fever. Although these exotic afflictions are extremely rare in British Columbia, mosquitos can still pose a serious health

concern. In addition to causing nuisance, many of the species collected locally also have a potential to impact public health, comfort and well-being. Extreme allergic reactions or secondary infections from irritated mosquito bites can occasionally require hospitalization.

Although locally rare, diseases such as canine heartworm, Western Equine Encephalitis (WEE) and West Nile virus (WNv) are transmitted between birds and mosquitos to family pets, humans, and livestock. A few years ago, the mosquito-associated flavivirus disease caused by Zika virus (ZIKV) became a prominent health concern in several areas of the world, including the southern USA. The current status of WNv and ZIKV in British Columbia, Canada and elsewhere in North America is briefly reviewed in Section 5.4; West Nile and Zika virus Update. The most current update is available at www.BCCDC.ca and Health Canada at www.canada.ca/en/health-canada or www.Hc-sc.gc.ca.

The ability of a particular species to vector disease such as WNv was established through the assignment of a competency rating by the BC Centres for Disease Control (BCCDC, 2005), based on a number of factors including mosquito life cycle, distribution, occurrence and preferred or potential blood meal hosts. Species were ranked from (0), or no potential to transmit disease, to (++++), or the ability to readily, and effectively transmit the disease. Species with a competency rating of (+++) and (++++) are the object of most vector-focused mosquito control programs. Since mosquitos capable of vectoring diseases to man are often the source of annoyance (human-biting), the control of mosquito populations known to cause nuisance also contributes to the protection of public health by controlling mosquito species also having the potential to vector disease.

Larval mosquito populations are sampled using a standardized, 350ml white plastic dipper. All samples were preserved and forwarded to *Duka Ltd.* corporate offices for taxonomic identification. Larval densities as low as one larvae/350ml dip sample in a roadside ditch or pond the size of backyard swimming pool (5m x 10m) has the potential to produce ~ 24,000 larvae. A one hectare site, about the size of 2 football fields would produce over 4,000,000 mosquitos. Larval populations in much of the program area average between 10-30 larvae/dip sample. Left untreated, the resultant adult mosquito populations are capable of causing noticeable annoyance for local area residents. Depending on the species, larval mosquito populations can range upwards of 100-500+ larvae/dip sample.

The key to successful mosquito control (population management) and a reduction in adult mosquito nuisance populations is through the early detection and timely control of larval development. Regular surveying and monitoring of potential mosquito development

sites (waterbodies), beginning with snowmelt and permanent habitats in early April, and for creek or lake level-influenced sites beginning in May, ensures that the onset of larval development is identified and treated. *Duka Ltd.* larval surveillance protocols ensured that larval sampling and monitoring of habitats was completed on a regular basis and typically every 6-10 days, depending on conditions.

3.2 Local Mosquito Species and Habitats

Mosquito development in the Central Okanagan occurs in a wide variety of larval habitats, ranging from temporary lake and river level-influenced flood and seepage water accumulations in farm fields and forested areas, to permanent, freshwater ponds, marshes, and ditches. In addition, any container, or depression, either natural or manmade, which is capable of holding water for several days to weeks can provide development habitat for larval mosquitos. Bird baths, plugged rain gutters, livestock watering troughs, unused pools, stored equipment, irrigation and surface water run-off collection ponds, ditches, tire ruts and catch basins are just a few examples of possible larval mosquito habitats.

There are over sixty different species of mosquitos, divided into five genera, found in British Columbia. These are *Aedes*, *Culex*, *Culiseta, Anopheles* and *Coquillettidia.* Each species has differences in life cycles, habitat, biting host preferences, and the time of the year when they occur as larvae and adults.

Aedes mosquitos lay their eggs on the soil where they overwinter and can remain viable, and able to hatch, for upwards of twenty years. Egg hatching is dependent on flooding, and is typically synchronous, with larval development occurring within hours of inundation. Larval population densities averaging 50-100 larvae/dip are not uncommon. These mosquitos are aggressive biting pests and prefer habitats such as fluctuating ditches and marshes and temporary habitats (*Aedes vexans*, *Aedes sticticus)* including surface water run-off, river seepage, floodwater and precipitation accumulations in low-lying fields and deciduous forest areas. *Aedes* mosquitos are most common early in the season, developing in response to fluctuating river levels and floodwater accumulations in farm fields, old oxbows, sloughs, and various ponds, depressions, and ditches. Since rainfall accumulations may immerse eggs several times a season, each initiating a further hatch, regular surveillance for *Aedes* mosquitos is required. Common *Aedes* species collected locally, and which can also transmit disease, include *Aedes melanimon* (+++)*, Aedes vexans* (++) and *Aedes sticticus* (+).

Anopheles, Culex and *Culiseta* mosquitos require a different set of cues to initiate the onset of larval development, including increasing day length and warmer temperatures. *Culex* and *Culiseta* prefer permanent and slow-draining, or frequently refilled sites including natural and man-made irrigation and display ponds, ditches, tire and tractor ruts, and containers such as stored tires, boats and buckets or livestock watering troughs. *Anopheles* mosquitos prefer permanent sites or slow draining and flowing ditches or stream margins. They are at their most numerous and widely distributed during mid to late summer when these conditions typically exist. Although populations and individual development sites are not usually as large, and hatching is not as synchronous as *Aedes* mosquitos,

Culex, *Culiseta* and *Anopheles* mosquitos are capable of causing extended nuisance by producing several generations in a typical season.

Species such as *Culex tarsalis* (++++) are able to withstand a high degree of pollution and can inhabit areas with high organic content, including septic field seepage, sewage lagoons and livestock hoof prints around barns, feed lots and along creeks. Other species like *Culex pipiens* (+++), *Culiseta inornata* (+++) and *Culiseta incidens* (++) are common mosquitos of freshwater habitats and in addition to causing recurring adult mosquito annoyance, several species also have the capacity to vector disease including WNv and Western Equine Encephalitis (WEE), also known as 'sleeping sickness' in horses. They can be a source of reportable annoyance by residents and visitors since preferred habitats include permanent, natural, and man-made waterbodies, temporary habitats and containers common to residential, commercial, recreational and agricultural properties.

A much less common genera*, Coquillettidia,* and the only species to occur in North America, *Coquillettidia perturbans,* uses permanent freshwater ponds or ditches with aquatic plants including cattails (*Typha sp.*) as habitat. It has a serrated larval siphon and pupal "trumpets" allowing it to attach to young cattails (*Typha* sp.) and similar aquatic plants so that it can access the air inside these hollow plants and "breathe" underwater. Because they are not free swimming like most larvae, they are not generally collected in routine larval sampling. They can be aggressive biters of man during the night and in shaded areas adjacent their development habitats, (Belton 1983).

Larval and adult mosquito surveys and sample collection over the past several years has resulted in the identification of over 25 different species of mosquitos occurring within the RDCO, City of Kelowna, District of Peachland, Westbank First Nations and adjacent areas. *Aedes* mosquitos are the most diverse and typically account for about 2/3 of all mosquito species collected. The balance of species collected are typically comprised of *Culiseta, Culex* and *Anopheles*. The diverse complex of mosquitos collected locally reflects the great variety of habitats and the impacts of local lake and river/creek levels, snowpack, and annual weather conditions on mosquito species occurrence and distribution.

3.3 Winter Snowpack, Weather and Mission Creek Levels

Numerous cues interact to affect the timing and magnitude of mosquito development in the Central Okanagan and Kelowna areas. The amount of winter snowfall accumulations in local mountains and their subsequent melt in late spring and early summer have a direct impact on water levels and the extent of flooding observed in low-lying fields, forests, and undeveloped areas adjacent to local lakes, rivers, and creeks.

Temperature and precipitation (weather) impacts on mosquito development and survival can vary depending on mosquito species and habitat. Weather conditions during April, May and June can either amplify, or reduce, the extent of flood and seepage water accumulations and resultant river levels from snowpack melt. Later in the season, during July and August, temperatures and precipitation can impact

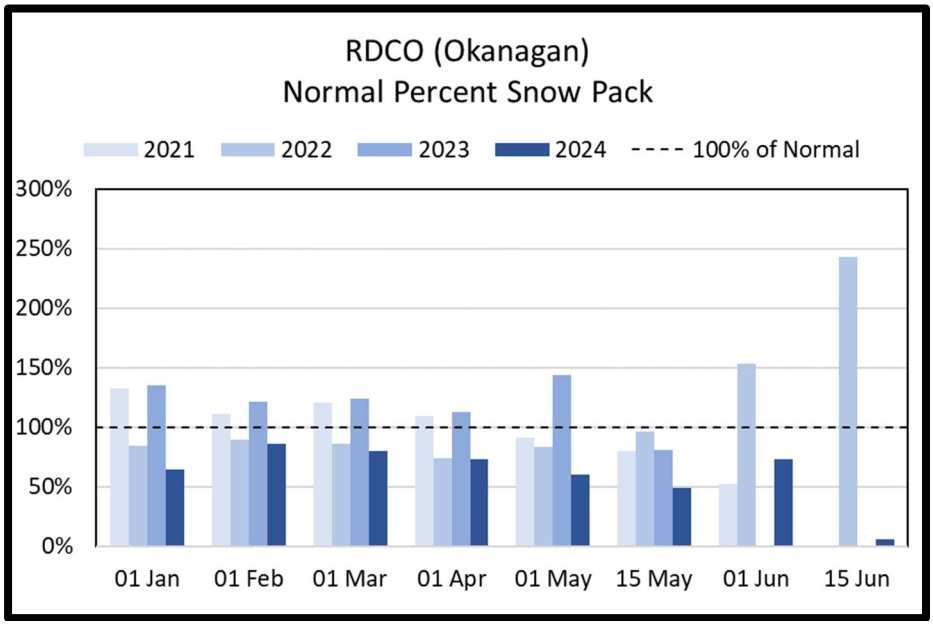
development site size, persistence, and larval distributions. Adult mosquito activity and survival are affected by temperatures and humidity.

During February, March, April and May, *Duka Ltd.* personnel regularly reviewed local snowpack conditions and long-range weather forecasts via online federal and provincial websites. Local lake and Mission Creek levels were monitored on a near-daily basis beginning in late April and extending throughout July. Ongoing habitat surveillance during the season confirmed creek and lake level impacts, development site status and allowed new, or previously unidentified mosquito development habitat to be characterized. New, or changing, larval habitats were photographed, mapped, catalogued, and added to the development site database for future monitoring and treatment, as required.

- ***Winter Snowpack***

Snow pack survey data collected by the BC Ministry of Environment (River Forecast Centre, www.bcrfc.env.gov.bc.ca/bulletins/watersupply) during the period 01 January to 15 June 2024 indicated a below average accumulation of snowfall in local mountains.

Snowpack measurements for the Okanagan snow basin peaked at 220mm snow-water equivalent on 01 March (80% of normal) and declined to 56mm on 15 May (49% of normal). Although 01 June had a snow water equivalent of 129mm (74% of normal) according to snow bulletins released by the province, this may be an unreliable extrapolation, as the raw data is more comparable to 2019 where snowpack was estimated at 4% of normal. (Chart 2, below).



<u>Chart 2:</u> Snow Surveys; Percent of Normal Snowpack for 01 January – 15 June, 2021-2024, Okanagan Snow Basin (www.bcrfc.gov.bc.ca)

- ***Weather***

Overall weather conditions for the Kelowna area during 2024 could be considered "warmer and wetter" compared with the 2019-2023 averages,(http://climate.weatheroffice.ec.gc.ca/climateData). Mean monthly temperatures from April to August were 0.7°C warmer on average relative to the 5-year mean, with July and August being notably warmer by 2.3°C and 2.5°C respectively, (Chart 3 below).

Monthly precipitation from April through August 2024 totaled 119 mm or about 56% higher than the five-year mean (Chart 3 below) and 29% more than the 10 year mean (2014-2024). July was the only summer month with below average precipitation this summer.

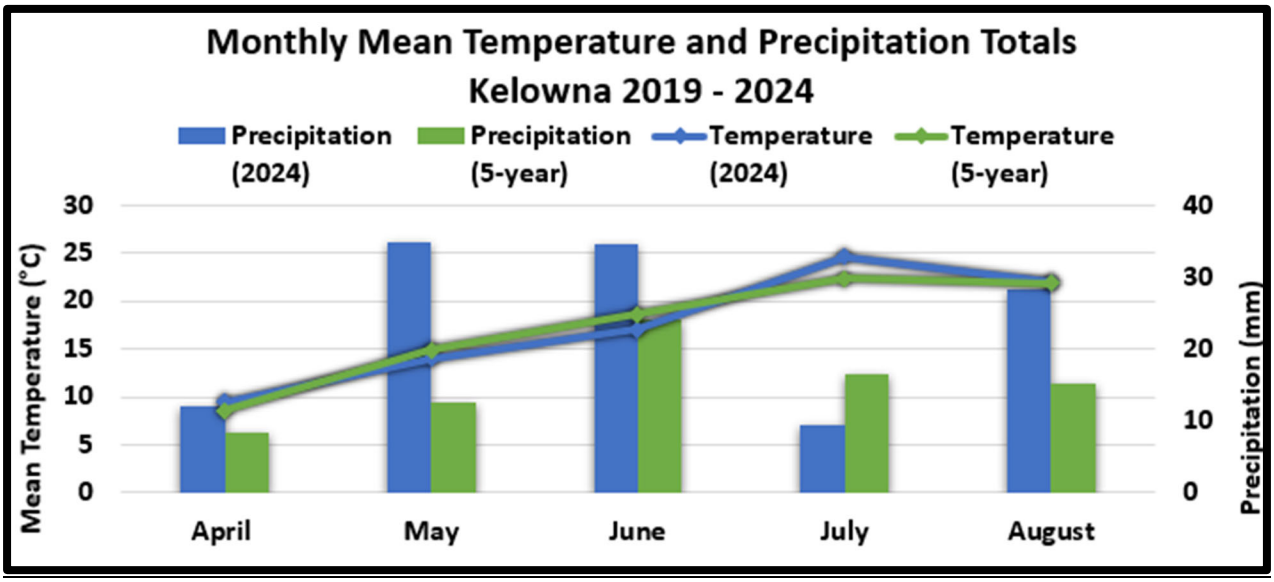


Chart 3: Monthly mean temperature and precipitation totals for April – August 2024 compared with the 2019-2023 averages. Measured at Kelowna UBCO, Station ID # 1123996

- ***Mission Creek Levels***

Increasing Mission Creek water levels flood adjacent, low-lying farm fields, forested areas and similar undeveloped lands adjacent the creek. Several season of data collection and comparison with larval development patterns has confirmed that Mission Creek levels exceeding 1.4 meters, measured at East Kelowna Station # 08NM116 (https://wateroffice.ec.gc.ca) cause flood and seepage water accumulations sufficient for larval mosquito eclosion (egg hatching) and development. The greater the number of days with water levels above 1.4m, the greater the amount of flooding and seepage water accumulations adjacent to Mission Creek.

Snowpack accumulations for 01 January to 15 June 2024 in the Okanagan Snow basin were below average, (Chart 4 and Figure 1 below). With fewer snowmelt water inputs this year, Mission Creek

remained well below the 1.4m threshold for widespread larval development and below the 10-year average for creek levels. Mission creek peaked at just 1.22m on 03 June, compared to the 5-year mean of 1.67m and 29 May. Mission creek experienced no freshet, and therefore seepage water accumulations and habitat for larval development in the area immediately adjacent to Mission Creek was greatly reduced this season when compared to 2020, 2022 and 2023.

Year	Freshet	Days > 1.4m	Peak Level	Peak Date
2024	N/A	0	1.222	03 June
2023	05 May - 24 May	13	1.638	23 May
2022	04 June - 04 July	16	2.040	14 June
2021	N/A	0	1.318	02 June
2020	03 May - 03 July	49	2.089	01 June
2019	N/A	0	1.265	15 May
2019 - 2023 Avg.	**14 May - 20 June**	**16**	**1.670**	**29 May**

Chart 4: Mission Creek Levels, measured at East Kelowna (Station # 08NM116) 2019-2024.

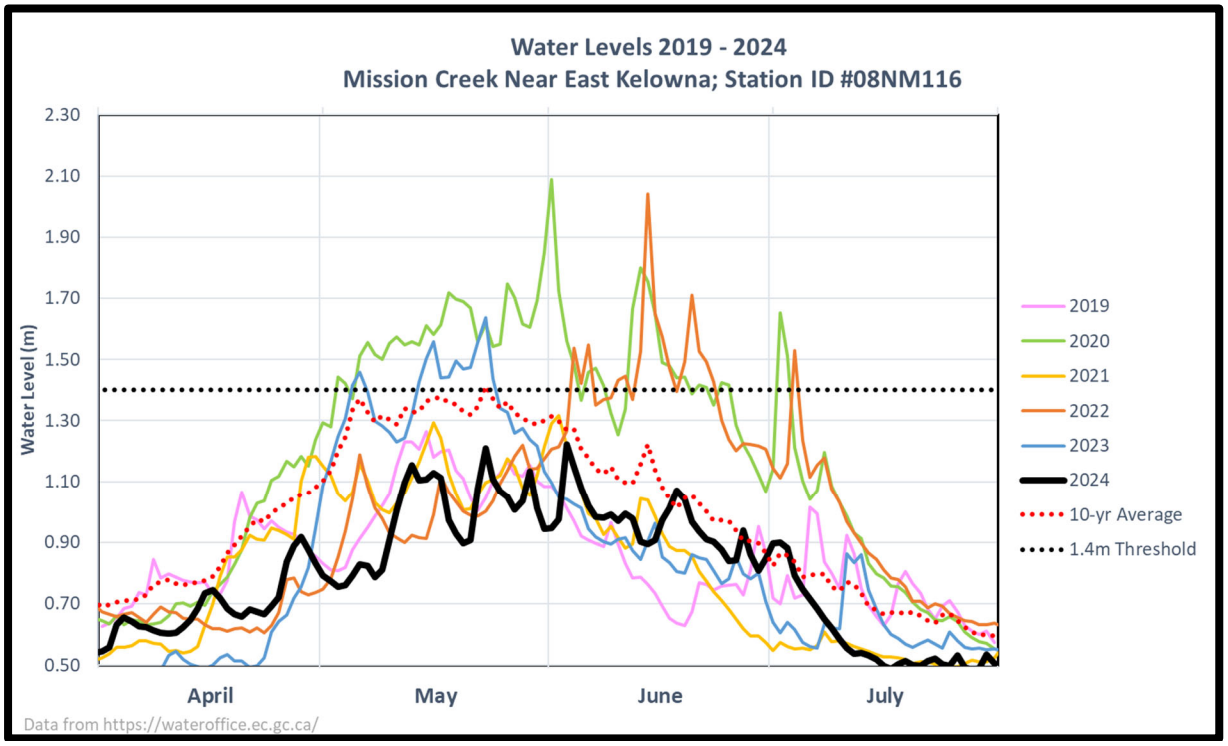


Figure 1: Mission Creek Levels, measured at East Kelowna (Station # 08NM116) 2019-2024.

3.4 Larval Mosquito Populations

Larval mosquito development habitats occurring within the boundaries of the RDCO include permanent, and temporary marshes, ponds, and sloughs, ditches, and depressions.

Temporary habitats, vary in size, from month to month, and year to year, in response to variable snowpack, weather and lake, creek and river levels. Occurring in areas with dense underbrush and forest growth, particularly along Mission Creek through the Gallagher and Mission areas, and adjacent the southern shorelines of Kalamalka, Wood and Ellison Lakes, these areas can be especially difficult to survey and treat. Many others are manmade and natural depressions which collect snowmelt early in the season and precipitation runoff following periods of frequent or extreme rainfall.

Beginning as early as mid-April, these depressions or waterbodies are initially filled or become increased in size with local snowmelt and precipitation, and for other sites with increasing water levels from mountain snowpack melt, flood, and seepage water accumulations. Elevated and fluctuating lake and creek levels during May and June can cause prolonged flooding in low-lying areas. Larval populations, typically *Aedes,* predominate in these sites for as long as they remain flooded.

Permanent or slow-draining ponds, small lakes, stagnant ditches provide potential season-long habitat for *Culex*, *Culiseta* and *Anopheles* mosquitos. Fluctuating in size and depth with precipitation and temperatures, larval development in these habitats often begins in late May and continues through into August, and with certain conditions into September.

Cattail marshes, which are located throughout the Central Okanagan, provide ready habitat for *Culex* and *Culiseta* mosquitos but can also provide habitat for a unique, and difficult to sample mosquito. *Coquillettidae perturbans*, an uncommon mosquito, often called the cattail mosquito, has a serrated larval siphon and pupal "trumpets" allowing it to attach to young cattails (*Typha* sp.) and similar aquatic plants so that it can access the air inside these hollow plants and "breathe" underwater. Because they are not free swimming like most larvae, they are not generally collected in routine larval sampling. They can be aggressive biters of man during the night and in shaded areas adjacent their development habitats.

In addition to temporary and permanent waterbodies, any container or depression (tire ruts, swales), either natural or manmade, and which is capable of holding water for several days, to several weeks can also provide development habitat for *Culex* and *Culiseta* larval mosquitos. Birdbaths, plugged rain gutters,

livestock watering troughs, stored equipment, tires and other man-made containers are just a few examples of other, possible *Culex* and *Culiseta* development habitats. Roadside catch basins (CBs) exist throughout the built-up areas of the City of Kelowna, Peachland, Westbank, and in several residential, rural subdivisions and industrial/commercial development areas in RDCO Electoral Areas. These CBs provide ideal habitat for *Culex pipiens* larvae since they retain water, organic matter (leaves, grass clippings etc.) and are typically absent of mosquito predators.

- ***Open Water Development Sites***

Several seasons of larval surveillance and comparison with precipitation and temperature data ensures the timely identification, and treatment, if necessary, of larval development in these sites. *Duka Ltd.* field biologists and technicians began surveys on 09 April by initially targeting those sites expected to be active early in the season. As part of these initial surveys, landowners and business or recreational facility operators and managers were contacted to confirm program participation and access procedures. These contacts provided an opportunity for field personnel to discuss control program operations, strategies and expected results with residents, managers, and property owners. Where practical, suggestions for reducing mosquito populations and annoyance on private and commercial properties were also provided. For larger properties these suggestions included grading of tire ruts and field harrows, filling or ditching of depressions to drain or eliminate them and agitation of irrigation and display ponds.

Following initial surveillance inspections of larval development habitats in early April subsequent site inspections were completed on a schedule of approximately every 6-10 days. With over 300 accessible development site locations and a potential +300 hectares of habitat, much of it located on private, rural, and agricultural properties, an organized, prioritized methodology has been developed to ensure timely larval surveillance and control.

Larval mosquito development habitats occurring within program boundaries included temporary and permanent open water habitats located on residential, agricultural, commercial, and industrial properties. Unused swimming pools, stagnant display and irrigation ponds, surface water catchment/retention ponds, ditches, marshes and depressions provided ready sources for larval mosquito development near residents, workers and visitors.

The frequent sampling protocols (6-10 days) employed for this program ensured timely larval detection and control, but also resulted in the collection of first instar larvae as a proportion of these samples. Because of their small size and immaturity, not all 1st instar specimens could be identified to species. In these situations, larval specimens were identified to genus.

Larval populations in the permanent, but fluctuating ponds at the Glenmore Landfill, a large and active source of mosquitos were again active on a weekly basis throughout the 2024 summer, beginning with initial sampling on 09 April. Larval populations typically averaged 10-20 larvae/dip sample with occasional populations of in excess of 50 larvae/dip sample identified.

Ponds at local golf courses in the Lake Country, Westbank and Kelowna Airport areas, and others in the Mission/Gallagher areas were frequently active with larval mosquito development during the season. Larval populations averaged from 1-6 larvae/dip with occasional populations in excess of 50 larvae/sample.

Flood and seepage water accumulations in farm fields and forested areas along the Mission Creek area, and in particular in the Hall Road area off KLO Road in Mission/Gallagher were reduced relative to previous years as a direct consequence of 2024 weather conditions. There are also many permanent ponds in the area which provide recurrent development habitat even when not influenced by increased creek levels. Larval mosquito development was observed on a near weekly basis for most sites in this area, and throughout the season. Larval populations typically ranged from 2-4 larvae/dip sample with occasional populations in excess of 20 larvae/dip sample. Recent changes in ownership for some parcels of land in this area and subsequent limitations to staff access for sampling and treatment of larval habitat may have contributed to the increase in adult nuisance complaints report from surrounding areas in previous seasons. Complaints were relatively low this year by comparison, and again, likely a reflection of lower Mission Creek levels with reduced flooding, seepage and larval development.

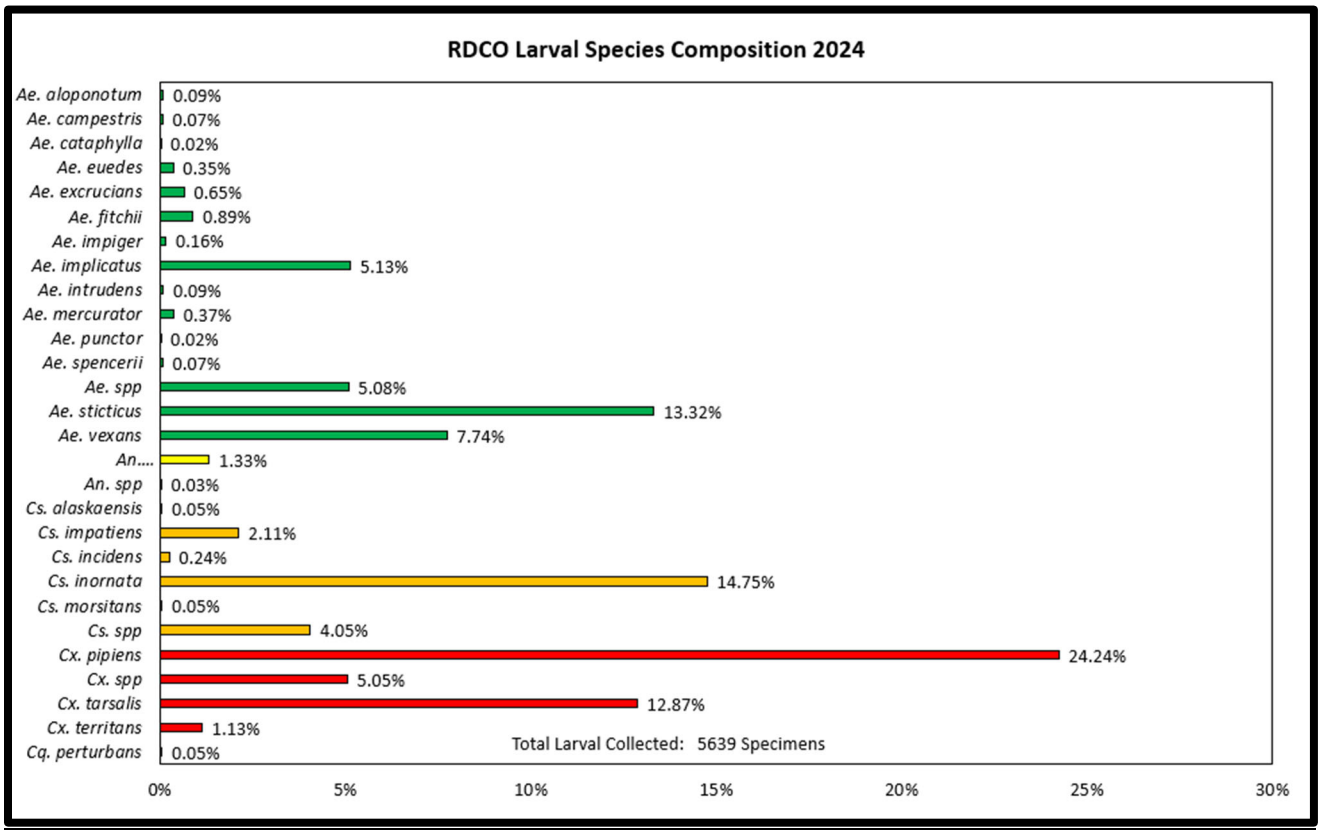
Larval surveys and sample collections were first completed on 09 April, and thereafter on a regular basis until 14 August 2024. A total of 2215 site inspections were completed at 294 individual development site locations. A total of 316 larval samples, containing over 5639 larval specimens, were collected, preserved, and forwarded to *Duka Ltd.* offices for taxonomic identification. Of this total, 805 larvae (14%) could only be identified to genus.

Twenty-four species of larval mosquitos were collected during 2024 sampling; 14 *Aedes*, 3 *Culex*, 5 *Culiseta,* and 1 *Anopheles* (Charts 4 and 5 below). All these mosquitos are capable, under the right conditions, of developing multiple generations during the season and causing reportable, and occasionally extreme annoyance, especially *Aedes*, which are noted as aggressive biters of man and animals (Belton 1983). *Culex* and *Culiseta* mosquitos are also noted pests of man and animals with several species recognized as highly competent vectors of West Nile virus.

Collected from snowmelt/creek seepage and precipitation-influenced sites, marshes, and ponds with fluctuating water levels, *Aedes spp* larvae accounted for 34.55% (1946/5639) of all samples identified in 2024. Of the fourteen *Aedes* species collected this season, *Aedes sticticus* was the most numerous, accounting for 13.32% of all larvae collected during 2024 (Charts 4 and 5 below). *Aedes sticticus* prefers river flood plains, cottonwood swamps, and irrigation run-off. *Aedes vexans* (7.86%) and *Aedes implicatus* (5.2%) were the next most numerous species of *Aedes* collected and develop under similar conditions, and in similar habitats as *Aedes sticticus.* *Aedes* mosquitoes, as a group, are aggressive pests of man and animals, and species such as *Ae. sticticus* and *Ae. vexans* are also identified as potential WNv vectors, (Belton, 2005).

Common to permanent development sites such as ponds, ditches and marshes, *Culex* mosquitos accounted for the largest portion of all larval specimens identified this season at 43.2% (2436/5639),

(Charts 4 and 5 below). *Culiseta* larvae accounted for 21.3% (1205/5639) of all larvae identified in 2024, and *Anopheles* accounted for 1.33% (75/5639) (Charts 4 and 5 below). In a rare occurrence, three specimens of *Coquillettidia perturbans*, commonly known as the cattail (*Typha sp*.) marsh mosquito, were also collected this year. With attachment to submerged aquatic plants using a serrated siphon, they are seldom collected as free-floating larvae. They can be aggressive, painful biters of humans and other mammals.



<u>Chart 4</u>: RDCO Larval mosquito identifications. Species composition based on 5639 specimens collected from various development site types from 09 April to 10 September 2024.

Culex pipiens, the "house mosquito" accounted for 24.24% of all larval mosquitos collected locally during 2024. It develops in permanent freshwater habitats, utilizing ponds, ditches and marshes. It also uses temporary sites extensively, including tire ruts, containers and roadside catch basins. It is the second highest ranked vector (+++) of West Nile virus by the BCCDC. *Culex pipiens* were most common in 2024 during the months of June and July, (Chart 5 below).

The fourth most common species this season, *Culex tarsalis,* accounted for 12.87% of larvae identified (Charts 4 above and 5 below). *Culex tarsalis* is a mosquito which can use almost any waterbody for development, such as flood and seepage waters, polluted/sewage waters, ditches, marshes, and

containers. It is an aggressive pest of man and animals and has the highest ranked (BCCDC, 2005) vector competency (++++) for West Nile virus.

A review of larval species distribution for the 2024 summer confirmed the expected change in diversity, population sizes and larval species occurrence over the course of the season (Chart 5 below). As seen in previous seasons (*Duka Ltd*, 2017-2022) and elsewhere throughout BC (*Duka Ltd.*, 2016 - 2023), *Aedes*, *Anopheles, Culex*, and *Culiseta* were all collected during the first half of the season (April and May) although *Aedes* were the predominant, with *Culex* and *Culiseta* larvae were the predominant mosquito larvae occurring later in summer (June through August) collections, (Chart 5 below).

Species	WNv Competence	Species Occurrence # of Samples	Total # of Individuals	% Occurrence	April				May				June				July					August				September			
				Week # →	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Ae. aloponotum	0	2	5	0.09%	1			4																				
Ae. campestris	0	2	4	0.07%		3		1																				
Ae. cataphylla	0	1	1	0.02%			1																					
Ae. euedes	0	11	20	0.35%	5			7	4				1								3							
Ae. excrucians	0	13	37	0.65%		4	11	4	14	4																		
Ae. fitchii	0 ?	15	51	0.89%	30			14	7																			
Ae. impiger	0	3	9	0.16%	9																							
Ae. implicatus	0	37	294	5.13%	251	24	3	4	2	4	2	2	2															
Ae. intrudens	0	3	5	0.09%	4		1																					
Ae. mercurator	0	12	21	0.37%	3	9	1	5	3																			
Ae. punctor	0	1	1	0.02%								1																
Ae. spencerii	0	2	4	0.07%				4																				
Ae. spp	N/A	41	291	5.08%	39	3	21	17	81	10	29	20	70	1														
Ae. sticticus	+ ?	96	763	13.32%	2	42	204	136	68	40	50	123	82	4								12						
Ae. vexans	+ +	42	443	7.74%			7	8	9	37	74	222	67	7								12						
An. punctipennis	+ ?	33	76	1.33%						9		9	1	3	1	1	7	12		12	16	5						
An. spp	N/A	2	2	0.03%							1							1										
Cs. alaskaensis	0	2	3	0.05%						3																		
Cs. impatiens	0 ?	56	121	2.11%					14	6	8	14	3	4	8	1	20	21	3	8	6	2				3		
Cs. incidens	+ + ?	14	14	0.24%					1	2		1		2	1			3		2	1	1						
Cs. inornata	+ + +	134	845	14.75%			6	16	56	48	85	74	34	43	38	2	148	120	27	36	76	29				7		
Cs. morsitans	+ + ?	3	3	0.05%							2							1										
Cs. spp	N/A	39	232	4.05%			5	3	45	24	4	4		6	15		36	34	3	53								
Cx. pipiens	+ + +	101	1388	24.24%					1	4	54	43	11	22	44	57	150	171	218	262	103	207	18			23		
Cx. spp	N/A	35	289	5.05%					8	46	12	4	45	65	6		13	3		78	9							
Cx. tarsalis	+ + + +	112	737	12.87%				2	43	64	92	69	23	25	61	14	49	115	44	81	15	36	4					
Cx. territans	0 ?	24	65	1.13%						4	2	11					4	22	2	8	8	4						
Cq. perturbans	+	2	3	0.05%								3																
Total		396	5727	100%	344	85	260	225	356	305	415	597	339	182	174	75	427	503	297	540	237	308	22	0	0	0	33	0	0

· **Species Occurrence:** Lowest Value — Highest Value

· West Nile Virus (WNv) competency was ranked by the BC Centres for Disease Control (2005) and Belton (2015). Mosquito species were ranked from (0), or no potential to transmit the disease, to (++++), or the ability to readily, and effectively transmit the disease.

Chart 5: RDCO Larval mosquito temporal distribution, comparing species composition for the sample collection period from 09 April – 10 September 2024.

In 2024, the majority (86.7%) of *Aedes* larvae were collected in April and May (Chart 5 above) and they accounted for 65% (1688/2590) of the total number of mosquitos collected in those months. In previous years this has been more pronounced, with a larger majority of *Aedes spp.* mosquitoes accounting for the total, especially in April and May (*Duka* Ltd., 2016-2023). *Aedes* mosquitos are very tolerant of coldwater temperatures and are typically the first larvae to develop. Laid on the soil, *Aedes* mosquito eggs hatch in response to surface water accumulations occurring early in the season with snowmelt, river/creek/lake seepage and precipitation. Reduced snowmelt accumulations around town and lower Mission Creek and lake (Ellison and Robert) levels, would have resulted in a smaller *Aedes*

hatch this year. As the 2024 summer progressed, low-lying flood and seepage water habitats, where they existed, drained or dried, and the diversity of *Aedes* mosquito species, and their proportion of the local mosquito complex during June and July similarly, decreased.

Aedes mosquitos accounted for just 8.6% (234/2708) of all larvae collected during June and July. As the summer progressed, many temporary, precipitation-influenced flood and seepage-influenced open water habitats drained and disappeared. These slow draining sites and other, permanent marshes, ponds and ditches were ideal habitat for *Culex* and *Culiseta* mosquitos which were the dominant (89.6%) larval mosquitos of the later, June – August, summer season (Chart 5 above).

- ***Catch Basins***

The most widespread development habitat within the RDCO are roadside catch basins (CBs). With over well over 15,000 CBs located along public roadways and in facility parking lots, not including those on private residential, commercial, recreational and industrial properties, they provide a potential source of adult mosquitos throughout the community.

Given the intent of catch basins is to collect water run-off to moderate flow rates and inputs into ravine and stream systems, and to also allow inorganic material (sand, gravel) and organic (leaves, twigs) to settle out, these sites often contain water for extended periods of time. Precipitation and surface water run-off from human activities including lawn watering, car and equipment washing, pool or hot tub cleaning or drainage etc. can increase the overall number of sites, and extent of time they can retain water. Several years of catch basin sampling has confirmed they can produce large populations of larvae, typically *Culex pipiens* (+++), an aggressive nuisance pest and very competent vector of West Nile virus (BCCDC, 2005).

Sampling for the presence of water and developing mosquito larvae was completed for 29 catch basin "clusters", comprising a total of 98 CBs. There were 23 clusters located throughout the Kelowna and Lake Country areas, 4 in Westbank and 2 in Peachland. These clusters, typically consisting of 2-5 catch basins each, were distributed throughout the control program to provide a representative sampling of larval activity onset.

Roadside catch basin clusters were sampled on a weekly basis, beginning the last week of May. Initial larval development on 29 May was observed in 16.3% of all sample CBs on average. Weekly monitoring of CBs from then on found larval occurrence to increase week over week with 38.9% of sampled CBs active with larvae on average by 20 – 21 June with some clusters having all CBs active with larvae and when initial catch basin treatments (Section 4.1, below) were completed.

3.5 Adult Mosquito Populations

Although larval population surveys and treatment activities are ongoing throughout the summer, adult mosquito annoyance may arise from untreated sites located within control program boundaries, or with wind-blown mosquitos emerging from areas outside the control program. To objectively measure the success and effectiveness of larviciding efforts for residents, adult mosquito population distributions and annoyance were monitored during the season.

Program personnel routinely assessed adult mosquito populations by measuring annoyance through biting or landing counts, observation and input from residents and property owners.

A "Standard Bite/Landing Count" involves exposing the forearm for a one-minute period and counting the mosquitos which land to bite, or attempt to bite, in that time period. Using an aspirator or inverted pill bottle, this method allows for adult mosquito specimens to be collected while they are actively attempting to, or landing to, bite field personnel. These biting/landing counts and adult specimen collection were typically completed while sampling larval development habitats and when setting up and retrieving light trap sampling equipment.

Populations in excess of 3 bpm are considered as sufficient to warrant the use of mosquito repellents and/or control devices, equipment or mosquito adulticides. When undertaken at a variety of locations, this provides a relative measure of the larvicide treatment success by comparing adult mosquito nuisance populations inside control program boundaries with that occurring outside of larval treatment areas, and from one area to another within the program. These biting/landing counts were typically completed while sampling larval development habitats and during the setting up and retrieval of light trap sampling equipment.

The second method of adult mosquito population assessment employed standard CDC (Atlanta) light traps. These portable traps use 6-volt batteries to activate a fan and an incandescent light bulb to generate heat, or a black light (infrared) bulb, as an attractant to female mosquitos searching for a blood meal. Typically operated for an 8-12-hour period (overnight, dusk-to-dawn), these traps were set up late in the afternoon or early evening. Light traps, and their samples, were retrieved the following morning, with any captured specimens forwarded to *Duka Ltd.* offices for enumeration and identification.

This equipment effectively samples mosquitos from the local population, and from an area of some 30-50m radius from a light trap location. Because of this limitation, they do not provide a comprehensive sample, population measurement or estimate for an entire neighbourhood, subdivision or community. Benefits associated with these traps include an objective, reproducible sampling method and the collection of undamaged specimens. Since mosquito species use different habitat types, the source

of localized, or reported adult mosquito annoyance, may be identified and for this reason traps are typically placed near a development site, or on a property near, or where, adult mosquito annoyance has been reported by the resident.

Adult mosquito samples were collected from a total of 57 different locations throughout the RDCO program area, either through landing/biting hand-captures or light trap equipment. Forty light traps were set up at 31 fixed locations for a total of 22 sampling nights between 16 May and 14 August, and mosquitos landing to bite were collected by *Duka Ltd.* field personnel on 41 separate occasions between 15 May and 12 August 2024. Landing and biting counts and samples were collected while field staff were surveying, sampling and treating larval development habitats or while servicing light trap equipment.

Species	WNv Competence	Species Occurrence # of Samples	Total # of Individuals	% Occurrence	April				May				June				July					August	
				Week # →	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Ae. aloponotum	0	12	21	13.46%						1	5	1		1	1	2		9	1				
Ae. communis	0	1	1	0.64%										1									
Ae. diantaeus	0	1	1	0.64%											1								
Ae. dorsalis	+ + +	10	10	6.41%							1		2	3	1				1				2
Ae. excrucians	0	5	6	3.85%																4	2		
Ae. implicatus	0	1	1	0.64%						1													
Ae. nigripes	0	1	4	2.56%						4													
Ae. provocans	0 ?	1	1	0.64%						1													
Ae. riparius	0	8	9	5.77%						6	1	1		1									
Ae. spencerii	0	1	1	0.64%							1												
Ae. spp	N/A	2	2	1.28%								1				1							
Ae. sticticus	+ ?	14	19	12.18%									1	4	1		5	2	1	3	2		
Ae. vexans	+ +	29	46	29.49%						3	1		4	15	2	5		3	3	5	5		
Cs. alaskaensis	0	1	1	0.64%									1										
Cs. incidens	+ + ?	2	4	2.56%																	3		1
Cs. inornata	+ + +	3	5	3.21%															1	1	3		
Cx. pipiens	+ + +	8	20	12.82%											2			8	4	1	5		
Cx. tarsalis	+ + + +	2	4	2.56%															3	1			
Total		93	156	100%	0	0	0	0	0	16	9	3	8	25	8	8	5	22	14	15	20	0	3

Notes: ·Species Occurrence: Lowest Value — Highest Value

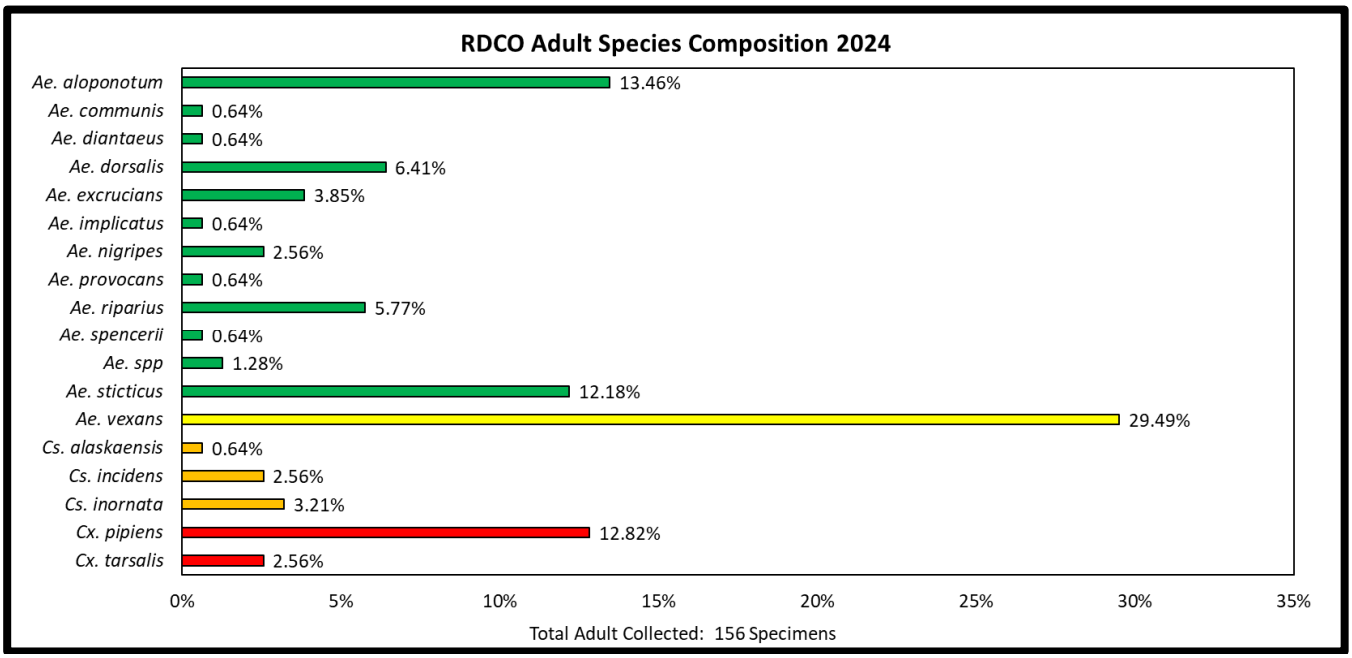
·West Nile Virus (WNv) competency was ranked by the BC Centres for Disease Control (2005) and Belton (2015). Mosquito species were ranked from (0), or no potential to transmit the disease, to (++++), or the ability to readily, and effectively transmit the disease.

Chart 6: RDCO Adult mosquito temporal distribution, comparing species composition for the sample collection period, 16 May – 14 August 2024 (N=156).

Light trap sampling and bite count collections were effective in collecting a variety of adult mosquitos. A total of 53 adult mosquito specimens were collected while they were landing to bite, and 103 adult mosquitos were collected by light trap sampling activities, (Chart 6).

Seventeen different mosquito species were collected as adults during 2024, (Chart 6 and Chart 7 below). The most numerous adult mosquitoes collected this season were *Aedes vexans* (29.5%), *Aedes aloponatum* (13.5%) and *Culex pipiens* (12.8%). Twelve species of *Aedes* were collected this season, and accounted for 78% of all adult specimens identified (Chart 7 below). *Culex* and *Culiseta* mosquitoes were at their most numerous in July, (Chart 6).

As the most numerous adult specimen caught this season, *Aedes vexans* is referenced by Belton (1984) as "probably the worst pest mosquito in southern British Columbia" as they are a very aggressive pest of man and domestic animals. The large proportion of *Aedes spp.* in adult collections this season may reflect the more historically normal (higher) summer precipitation, as well as focused sampling in areas susceptible to flooding near mission creek. As with larval populations, *Aedes* adults usually predominate earlier in the season, and *Culex* and *Culiseta* predominate in the latter half.



<u>Chart 6</u>: RDCO Adult mosquito collections. A total of 156 specimens collected while they were landing to bite and with CDC (Atlanta) light traps, 16 May – 14 August 2024.

Aedes mosquitos, because of their aggressive biting behaviour, are more likely to be collected while attempting to bite. They accounted for 96% of the adult mosquitos collected while landing to bite. Of the 75 specimens collected in light trap sampling, 59% were *Aedes*, 29% were *Culex,* and 12% were *Culiseta*.

All of the species of adult mosquitos collected this season can cause nuisance, and several including *Aedes vexans, Aedes sticticus, Culex pipiens* and *Culex tarsalis* have also been identified as West Nile virus vectors. *Culex tarsalis* (++++) and *Culex pipiens* (+++) are two of the most competent vectors of WNv. *Culex territans* is usually present in adult samples most seasons but is not a nuisance pest as it prefers to bite amphibians.

Adult mosquito populations and annoyance for the great majority of Kelowna, West Kelowna and RDCO residents could be summarized as minimal, to non-existent, during the 2024 season. Adult mosquito annoyance where it was observed, and most frequently reported by residents was from the Mission and

Gallagher areas, (See Chart 1 above). These areas are comprised of large rural, treed and landscaped properties and small lakes, marshes, sloughs, natural and man-made ponds, which often have difficult access because of size and vegetated shorelines or forest and brush.

Of the 34 service request calls received this season, 15 included reports of adult mosquitos and 14 were to report waterbodies on public land or private properties. The remaining six service requests were to confirm participation in the control program, or to request more information.

Duka Ltd. field staff conversations with local golf course operators, greens keeping crews and patrons were all very positive, with many commenting on the low number of adult mosquitos. Other recreational and facility operators, Glenmore landfill staff, businesses, property owners and residents who interacted with *Duka Ltd* personnel this season were very appreciative of the services available to them. Residents, staff and managers were always helpful to program personnel providing golf carts, combinations or keys to gate locks, dog names and site tours as required.

4.0 MOSQUITO CONTROL AND POPULATION MANAGEMENT

The Regional District of Central Okanagan (RDCO) Nuisance and Vector Mosquito Surveillance and Control Program employs a pro-active, IPM approach to control which maximizes the environmental compatibility and sustainability of the annual program. It reduces the potential for adult mosquito annoyance by focusing efforts on the identification and control, or prevention, of larval mosquito development. The program achieves this by using public education, physical site modifications (roadside grading, ditch maintenance, removal of containers, used tire collection) and larval control using the biological (bacterial) mosquito larvicides VectoBac 200G (*Bacillus thuringiensis* var. *israelensis* (*Bti*) *Serotype H-14, Strain 65-52*) and VectoLex WSP or CG (*Bacillus sphaericus*). Factors limiting program success are extreme, or prolonged Mission Creek or local lake levels, above average snowpack and/or rate of melt, weather conditions, larvicide treatment scope (total area treated) and frequency of surveillance and applications.

A major emphasis for effective management of mosquito populations in the program area involves the timely surveillance and control of the widespread and synchronous hatching of *Aedes* mosquitos. Given that *Aedes* mosquitos are the predominant larval species of the early season (Chart 5 above), and are aggressive pests of man, the timely identification of active larval habitats is particularly important for initial program operations, both for the purposes of program efficacy, and efficiency.

With recurrent, or extended flooding of Mission Creek or frequent precipitation during late April, May, and June there can be multiple hatches of *Aedes* larval mosquitos. As these sites slowly drain, or are further influenced by irrigation run-off or precipitation, they can become ideal habitat for *Culex* and *Culiseta* mosquito development beginning in June and throughout the summer. In addition to being notable pests of man, several species of *Aedes*, *Culex* and *Culiseta* (Charts 5 and 7 above) have also been

identified by the BCCDC as potential vectors of West Nile virus and have been collected locally (*Duka Ltd.,* 2016-2022).

Routine sampling of flood and seepage water habitats and correlation with melting snowpack, fluctuating creek or lake levels and precipitation ensures accurate treatment timing, particularly for *Aedes.* Permanent ponds, marshes, ditches, and containers, including catch basins, provide ideal habitat for *Culex* and *Culiseta* larval populations. Routine and regular larval surveillance may need to be initiated as soon as early April, and as late as early September, depending on conditions and program scope.

4.1 Larval Mosquito Control and Prevention

Program biologists continue to identify larval mosquito habitats which can be eliminated, reduced in size, or altered to limit their use by mosquitos. Restoring the flow through man-made ditches or ponds can reduce their suitability as mosquito development sites. Grading or filling of tire ruts and depressions or ditching of low-lying areas to facilitate draining can reduce standing water and potential larval development. The removal or regular drainage of containers such as barrels, uncovered or unused pools, toys, boats or canoes and regular changes of water in livestock watering troughs and bird baths is easily done and eliminates their potential to produce mosquitoes.

When encountered by program personnel, containers are typically emptied or drained. Where appropriate, property owners, facility managers and public works personnel are provided with site specific recommendations for reducing larval development habitat and adult mosquito annoyance.

Uncovered tires stored outdoors or left in fields and behind sheds can capture, and hold rainwater and leaves blown by the wind, heat up quickly in the sun, and provide perfect habitat for mosquitos to develop, particularly mosquitos of the genus *Culex* which prefer warm water and can utilize containers. The annual Used Tire Roundup was once again offered to RDCO residents and property owners on the second weekend of September. In partnership with the Tire Stewardship BC, unused, old, and damaged tires (cars, trucks, tractor, and bike tires) can be dropped off to be taken away and recycled into products such as truck box liners, athletic track and playground surfaces. This season, more than 1400 vehicle tires were collected and removed as potential larval mosquito development habitat. This was approximately twice what was collected last year (2023), and a return to numbers in previous seasons. Last year's turnout likely reflected the wildfire situation and evacuations affecting the ability, and desire of Kelowna and West Kelowna residents to access the service.

Removal or alteration of mosquito producing habitat does not necessarily mean drainage resulting in habitat destruction for other organisms and natural predators. Increasing the depths of ponds to over 30 cm or encouraging water movement reduces larval mosquito use. It is best accomplished with smaller, temporary, or defined development sites located on private and commercial properties. Several private properties and golf courses have installed new, or additional fountains, and/or water pumps, in the past few seasons with a resultant exclusion of larval development in these ponds. Public works personnel maintenance of flow in ditches, grading of tire ruts and depressions along roadsides and in vacant areas, removes potential larval development habitats.

The preservation or enhancement of balanced wetland habitats has the best opportunity for a meaningful long-term contribution to overall mosquito control program success through reduction of mosquito populations and enhancement of natural controls including insect, fish, and birds.

Large-scale, physical alterations of the low-lying areas adjacent Mission Creek and the filling, drainage or alteration of most natural and man-made marshes, ponds and ditch systems is impractical, undesirable, or fiscally prohibitive. The nature, purpose, and intent of many of these permanent ponds and marshes requires that they not be eliminated, and as such, routine surveillance and treatment of developing larval populations is required. For these sites, the only practical solution for reducing mosquito populations is through the use of the granular, biological mosquito larvicides such as VectoBac 200G (PCP # 18158) or VectoLex CG and WSP (PCP # 28008, 28009).

VectoBac 200G contains bacterial spores of the bacterium *Bacillus thuringiensis* var. *israelensis* (*Bti*) *Serotype H-14, Strain AM65-52*. Its mode of action is on the larval mosquito stomach. It is very specific, producing rapid lethal effects in larval mosquitoes within hours. It has no residual activity, does not bio-accumulate, and has no impact on beneficial organisms found in mosquito development habitats. The timing of all VectoBac 200G applications ensured they were directed at the most susceptible 1st through 3rd larval instar stages.

VectoBac 200G and VectoLex CG are formulated on corn cob granules for ease of application and are recommended by the manufacturer for use in standing water habitats including temporary and permanent pools, irrigation or roadside ditches, natural marshes or estuarine areas, waters contiguous to fish-bearing waters, catch basins and sewage lagoons. Similar to VectoBac 200G, VectoLex CG and WSP also contain a naturally occurring, spore-forming soil bacterium. VectoLex contains spores and crystals produced by *Bacillus sphaericus.* It also is classed as a bio-rational, rather than conventional, pesticide. Like VectoBac, VectoLex acts on the larval mosquito stomach and must be eaten to be effective. VectoLex is very specific

and produces lethal effects in a narrow range of mosquito species, including *Coquillettidia perturbans* and most *Culex* mosquito species. As with VectoBac, It does not have any effects on man or animals, fish and other insects which may use these aquatic habitats.

Operationally, the important differences between VectoLex and VectoBac are speed of action and persistence in the larval habitat. Larval mortality can take several days for VectoLex versus several hours with VectoBac 200G. This occurs because *B. sphaericus* is more stable, has a slower settling rate in the water column and the unique ability for its spores to germinate, grow and reproduce in dead mosquito larvae. This is known as recycling and is the mechanism which allows VectoLex to provide long-term, extended control (+28 days in many jurisdictions) of recurring larval mosquito development. VectoLex CG is recommended by the manufacturer for use in standing water habitats including temporary and permanent pools in pastures and woodlots, irrigation or roadside ditches, natural marshes or estuarine areas, waters contiguous to fish-bearing waters, catch basins and sewage lagoons.

A total of 641.77 kilograms of VectoBac 200G were applied to a total area of 84.285 hectares of active larval mosquito development habitat located within the RDCO, Kelowna area, (Table 1). A total of 215 sites were treated on 923 separate occasions between 09 April and 14 August. Although many sites required only 1 or 2 treatments during 2024, numerous sites were treated on 3 or 4 occasions and several sites were treated on 10 or more occasions. In addition, 16 sites located within the boundaries of the Westbank First Nations were treated on at total of 71 occasions during 2024 with 19.45 kg of VectoBac 200G to control larval development, (Table 2). Most sites in the Westbank First Nation required 1 – 3 treatments, but 6 sites required at least treatments and one site required eleven.

The Glenmore Landfill, comprised of several ponds (Sites GM 19A-I), is one of the largest and most prolific larval development habitats. These sites are typically the first to become active, as early as mid-March when ice can still be found on some ponds and the edges of larger, deeper ponds. Requiring treatment on a near-weekly basis, this area required 54.97 kg of VectoBac 200G during 2024. Several shallow ponds in Glenmore (Tutt Ranch/UBCO), Site # GM07A-D, were also repeatedly active and treated on 13 occasions with a total of 27.65 kg of VectoBac 200G during 2024, (Table 1). Precipitation-filled depressions and tire ruts in a flooded field off Curtis Road in Glenmore (Site GM10) were also active on 13 occasions during 2024, with larval populations ranging from 1 to 40 larvae / dip.

Mission Creek seepage in farm fields at 3885 Gordon Drive (Sites #MIS13B&C) was active with larval development on at least 10 occasions and required 46.84 kg of VectoBac 200G. Several Mission Creek level-influenced marshes and temporary floodwater areas, Sites #GG22A&C, #GG25A&B, #GG29A&B, and GG38 in the Gallagher neighbourhood were active between six and seven times, (Table 1).

Chichester wetland park (Site #RT19) was active on 6 occasions between 08 May to 08 August, and required a total of 5.88 kg of VectoBac 200G. Farm irrigation channels at Mill Creek Farm (AP02) were treated during all ten inspections, requiring a total of 42.80Kg of VectoBac 200G for larval populations ranging from 2-20 larvae/dip sample.

Post-application monitoring of all VectoBac 200G applications indicated excellent results had been achieved, with observed mortalities within the first 1-2 hours post-treatment typically greater than 95%.

In an attempt to reduce mosquito populations in areas with difficult access, because of thick, overgrown, or dense vegetation (i.e. blackberries, brush or *Typha* sp. cattails), and a history of adult mosquito nuisance reports, the long-acting VectoLex WSP (Water-Soluble Pouch) was used for treatments. Already used throughout the program for catch basin treatments, these 10gm satchels (2cm X 2cm) can be readily thrown into sites where the bio-degradable, glucose-based bag quickly dissolves, and the granules disperse across the water surface.

VectoLex WSP was again (since 2022) used in select, permanent waterbodies such as Sites # MIS15A and MIS15B near K.L.O. Road. Other difficult to access sites which had and with a history adult mosquito nuisance complaints nearby included Sites # GG26, GG36 and RT19. Its use in other programs for several years has shown a reduction adult mosquito nuisance occurring near cattail swamps and has suggested, at least anecdotally, that it is providing control of difficult to sample species such as *Coquillettidia perturbans.* A total of 2.87 kg (287 pouches) of VectoLex WSP was applied for this purpose during 30 treatments in 2024, (Table 3).

Catch basins can provide season-long larval development habitat and are treated with VectoLex CG and WSP. Alternative larval control products such as juvenile growth hormone analogs (Altosid/methoprene) can have negative impacts on other aquatic insects, arthropods and amphibians and are not used in the program developed for the RDCO by *Duka Ltd.*

Duka Ltd. personnel surveyed some 98 catch basins (CBs), divided into 29 "clusters" of 2-5 catch basins, distributed throughout the control program, on a regular, weekly basis beginning the last week of May. Sampling of the CB clusters prior to treatment confirmed there was larval development occurring in +30% to 100% of CB clusters being sampled. Once widespread larval development was underway, *Duka Ltd.* personnel surveyed +12,000 roadside catch basins for the presence, or absence of water, as part of each treatment campaign.

All catch basins holding water at the time of treatment inspection were treated with VectoLex WSP (*Bacillus sphaericus*) 10gm water soluble pouches or VectoLex CG granules. A total of 24,255 roadside catch basins (CBs) were treated during June and July 2024 within the defined boundaries of the RDCO program. Catch basin treatments completed 24-27 June 2024, included 10,735 CBs located throughout RDCO/Kelowna and Lake Country, 425 CBs in Peachland, and 1,232 CBs within in the Westbank First Nation. During the second treatment 21-24 July 2024, a total of 10,054 CBs located throughout RDCO/Kelowna and Lake Country, 451 CBs in Peachland, and 1328 CBs within the Westbank First Nation were treated to control larval development.

Adult mosquito monitoring and anecdotal reports from residents, businesses, golf course operators and visitors confirmed that adult mosquito annoyance for the great majority of RDCO residents, workers and visitors was minimal during 2024. Adult mosquitos and annoyance, where it was reported, was typically from areas with large and/or numerous and difficult to access development sites. The annoyance was usually short-lived and localized.

4.2 Adult Mosquito Control and Nuisance Reduction

Adult mosquito control (adulticiding) using truck mounted or backpack ULV (ultra-low volume) sprayers has not been a component of routine nuisance mosquito control programs in BC and Yukon for over twenty years.

Adulticide provides temporary relief from adult mosquito annoyance and repeated applications, along an approved route, are required to provide extended relief. The application method, a mist applied to the air, and the non-target specificity of adulticide products, are such that the potential for impacts on insects other than mosquitos makes this the least desired method for routine mosquito population management. When deployed, the natural chrysanthemum derived pyrethrins, or synthetic equivalents are preferred. These products have a low persistence in the environment and quickly degrade within hours of exposure to sunlight.

Adulticiding **IS NOT** a component of the RDCO nuisance and vector mosquito surveillance and control program.

- ***Devices, Pesticides, and Repellants***

Adult mosquito collection devices such as Mosquito Magnets™ and Bite Shield™, which use propane to generate CO_2 will collect adult mosquitos and are marketed by several companies for use by property owners. Although they do collect adult mosquitos, with a collection range of about ½ hectare (one acre), their ability to reduce mosquito populations sufficiently to provide relief from annoyance on a community level is unlikely without the deployment of numerous units. Their use at a single property/residence though, can have a noticeable impact by collecting adult mosquitos and reducing annoyance.

Citronella candles, mosquito coils, Konk™ Automatic Aerosol Sprayers and other such products are marketed as mosquito repellants, or for adult mosquito or biting insect control. These are readily available to residents, campers, and property owners.

- ***Natural Predators***

Although flying insects can form a large component of the diet for flying insectivores (*e.g.* bats, swallows, Purple Martins), there is no scientific evidence which suggests that birds or bats provide a detectable level of mosquito control. Both birds and bats are opportunistic feeders and adult mosquitos have been identified as a very small component (<2%) of their diet (Fang 2010, Gonsalves *et al*, 2013). They are not however, scientifically recognized as able to provide any real impact on mosquito populations when used solely as a mosquito population control option. Reported to eat up to 300 mosquitos a day, a total of some 13,000 birds and/or bats would be required to consume the mosquitos emerging from a single hectare of habitat where upwards of 4,000,000 mosquitos can emerge.

Interested residents are, however, still encouraged to install bird nesting boxes or bat houses if they wish. It allows individuals to contribute to a comprehensive, integrated mosquito control program, to enhance the natural control of mosquito populations and it may provide residents with a sense of reduced adult mosquito annoyance. Additional predators for adult mosquitos include frogs and insects such as wasps, deer flies, dragonflies, damsel flies, etc. and spiders.

The key to successful mosquito control (population management) and a reduction in adult mosquito nuisance populations is through the early detection and timely control, or prevention, of larval development.

Preserving and enhancing natural predator populations, including aquatic larval predators (diving beetles, dragon flies, stickleback fish etc.), and reducing, or eliminating larval mosquito habitats including temporary, water-holding, tire ruts and depressions, containers or unused swimming pools, tarped equipment or bird baths contributes to sustainable control operations and supports a natural contribution to the suppression of local adult mosquito populations.

As mentioned previously, a one-hectare site, about the size of 2 football fields, with a larval population density of just 1 larvae/dip sample can produce 4,285,714 mosquitos. Larval populations in much of the program area average between 10-30 larvae/dip sample. With over 150 hectares of potential habitat, located in over 300 different locations, and with many of these located within 100-200m of residents and businesses, the sheer potential for adult mosquito populations, likely in the 100s of millions, would make a reliance on solely natural controls unlikely to have any impact on annoyance levels for area residents.

Adult mosquito monitoring and anecdotal reports from residents, farmers/orchardists, golfers, visitors, and the general public confirmed that adult mosquito annoyance for most areas of the Regional District and communities of Kelowna, Lake Country, West Kelowna and Peachland were minimal to non-existent, or short-lived and localized.

5.0 CONTROL PROGRAM EVALUATION AND RECOMMENDATIONS

Larval development site identification, sampling and targeted, timely treatments with analysis of results, are primary components of successful, ongoing IPM-focused mosquito control programs. A review of winter snowpack, water levels and local weather conditions, in conjunction with a sound knowledge of mosquito biology, local species and development sites, are required to ensure timely surveying and monitoring. Left untreated, larval mosquitos would complete their development to become a possible source of adult mosquito annoyance. Factors limiting program success are larvicide treatment scope and frequency of surveillance and application. Increasing the scope (total area) and frequency of larval monitoring and applications reduces overall mosquito populations and improves program effectiveness.

Once underway, larval development in Kelowna, Westbank First Nation lands and adjacent RDCO areas has been observed to occur on a near-continuous, or recurrent basis in many permanent and slow draining sites. Larval development has been observed as early as the first week of April and as late as the third week of August. The forested area, farm fields and large rural properties adjacent Mission Creek, and the numerous permanent ponds scattered throughout area at golf courses, public and private lands provide ideal larval mosquito development habitat. Flood and seepage water-influenced sites typically produce larval mosquitos for as long as they contain water and permanent ponds can produce mosquitos throughout the season. Rigorous and extensive sampling of these often-expansive sites allows for individual sites, or portions of sites, to be identified for timely treatments.

Mosquito control programs should be evaluated annually, and the results achieved this year confirms that it continues to meet the needs of residents. A total of 15 of the 34 service requests (44%) received by *Duka Ltd.* in 2024 included reports of adult mosquito annoyance or observation. This represents a significant reduction from last year, and likely reflects the reduced flooding seen this year in the Mission Creek area where complaints are typically concentrated. Areas adjacent to Mission Creek are prone to flooding, and as a result *Aedes* development is typically widespread and extensive.

For the great majority of Kelowna, Westbank, Peachland and adjacent RDCO Electoral area residents, adult mosquito annoyance was non-existent, minimal, or short-lived. The many positive reports and discussions *Duka Ltd.* field personnel had with area residents confirmed the overall success of the 2024 Nuisance and Vector Mosquito Surveillance Control Program. There is strong, positive support for this safe and effective annual mosquito control program.

5.1 Public Relations and Education

Regular and routine interactions with residential and rural property owners, golf course managers, farmers, orchardists and their staff, brochures and 'doorknob hangers' provided residents and area visitors with practical, useful information and updates on control program operations. Regular and frequent newspaper articles, radio and television interviews, advertisements, website and social media posts by the RDCO Communications and Intergovernmental Affairs Coordinator and *Duka Ltd.* provided frequent, and current information about ongoing program operations. The annual Tire Roundup was offered again in September 2024, collecting more than 1400 tires for recycling. This is a return to average collection volumes from recent seasons and more than twice that collected in 2023. The forest fires and evacuation orders of July and August 2023 were the likely cause of reduced collections last season.

Responding to resident requests for service allows program personnel to locate new or previously undetected development habitat and provides an opportunity to discuss mosquito control program operations and goals. Wherever practical, residents are advised of options for physical control or maintenance to limit mosquito development and adult mosquito annoyance on their property. A total of 20 telephone calls and emails were received from residents wishing to confirm participation in the program and property access for field staff, to report observations of stagnant water and potential larval habitat, or for more information about the program.

All private property owners, and outdoor facility operators, golf course, campground and landfill managers were very helpful to *Duka Ltd.* field personnel providing ready access to their lands and businesses for larval mosquito surveillance and control. All *Duka Ltd.* office, field and management staff contacts with the general public, business operators, visitors and residents were very positive.

5.2 Surveying, Monitoring and Environmental Effects

The goal of the annual RDCO Nuisance and Vector Mosquito Surveillance and Control Program is to identify and prevent, or control, the widespread development of larval populations. This will suppress overall mosquito populations and reduce the potential for adult mosquito occurrence and nuisance. Surveying and monitoring of larval habitats (water bodies) and adult harbourage (treed, woodland) areas for the presence of mosquitos determines the need for control and treatment decisions. Regular, and frequent development site surveillance is essential to this successful annual larval mosquito control program.

A review of winter snowpack accumulations, seasonal precipitation, and temperatures, in conjunction with a sound knowledge of mosquito biology, local development habitats, species complex and their interactions are necessary to ensure effective and timely control. Program data collected over the past few years confirms that extended periods of Mission Creek levels, measured in excess 1.4m, will give rise to seepage water accumulations in adjacent farm fields and forested areas resulting in recurring larval mosquito development. Weather and water level information allows the onset of larval mosquito development to be forecast and surveillance focused on larval species occurrence and distributions.

Twenty-four different species of larval mosquitos were collected during the 2024 season. Collected from flood and seepage water-influenced sites, marshes, and permanent ponds with fluctuating water levels, 14 species of *Aedes* mosquitos accounted for some 34.05% of all larval samples identified. *Culex* mosquitos (3 species) were the most common larvae collected in 2024 and accounted for 43.29% of all larvae collected and identified. *Culiseta* mosquitos accounted for 21.38% of all larvae collected, and *Anopheles* for 1.33% (Charts 4 and 5, above).

Seventeen mosquito species were caught as adults this year: 12 from *Aedes*, 3 from *Culiseta* and 2 from *Culex*. Most specimens caught this year were from the genus *Aedes* (78.21%) with the most numerous species being *Aedes vexans* which comprised 29.5% of the total sample. The second most common mosquito in adult samples was the locally uncommon *Aedes aloponatum*, comprising 13.46% of the sample. *Culex pipiens*, a highly competent WNv vector, was also prominent this season, and represented 12.8% of the total sampled adults. *Aedes* are very pestiferous and prolific mosquito type, Other species collected in light traps and as part of biting/landing counts included: *Ae. communis*, *Ae. diantaeus, Ae. dorsalis, Ae. excrucians, Ae. implicatus, Ae. nigripes, Ae. provocans, Ae. riparius, Ae. spencerii, Ae. sticticus, Cs. alaskaensis, Cs. incidens, Cs. inornate, Cx. tarsalis,* each accounting for 0.6 – 13.3% of all adult specimens collected in 2024 (Charts 6 and 7 above).

Light trap sampling of adult mosquitos at fixed locations provides information on localized populations, and specifically those occurring within 30-50m of its position. To provide an effective measure of overall program efficacy, traps would need to be much more numerous, set up in more places and more frequently. Their best use is as a means to measure populations and collect samples in areas where repeated reports of annoyance are received. Mosquito species identification from collections in traps deployed under this protocol would help to identify potential development habitats affecting an area, allowing them to be targeted for larval surveillance and control.

Ground-based treatment to accessible habitats controlled recurrent larval mosquito development in areas located adjacent to numerous private residences, commercial and recreational operations, campgrounds and golf course areas. Weekly surveying of known development sites is necessary until they drain or are no longer producing larval mosquitos. This ensures that larvae are identified and controlled at their source, and in a timely fashion. The annual magnitude of treatments, and larvicide used, is determined by a variety of factors, not limited to, but including, habitat type (permanent or temporary), larval species, winter snowpack accumulations, summer precipitation, temperatures and local lake, river and creek water levels.

Capable of vectoring diseases such as West Nile virus (WNv), the control of *Aedes* vexans (+), *Ae. sticticus* (+), and the highly competent vectors, *Culex tarsalis* (++++), *Culex pipiens* (+++) and *Culiseta inornata* (+++) as part of the annual Nuisance and Vector Mosquito Surveillance and Control Program not only suppresses adult mosquito populations to reduce potential annoyance, but also contributes to the protection of public health and potential risks from WNv.

Catch basins provide the most widespread type of larval mosquito development habitat and potential source of adult mosquitos within the defined areas of the RDCO. Typically providing habitat for *Culex pipiens* mosquitos, their control is essential to limit localized annoyance and the possibility for disease transmission within "built-up" residential, industrial, and commercial areas of the Regional District, City of Kelowna, Westbank and Peachland. *Culex pipiens* mosquitos can have multiple generations (multi-voltine) in a season and adult females will enter buildings in search of blood meal. They have a WNv ranking for competency of (+++).

5.3 Mosquito Control Options

An important element for smaller scale control of mosquito populations near residential, commercial, and recreational areas is the reduction, modification, or elimination of temporary larval mosquito habitats. Locally, this practice should include physical mosquito control through source reduction, including the filling, and draining of depressions, tire ruts or excavations and the re-establishment of waterflow in ditches, ponds and sloughs as a preferred method of control. Once completed it requires either no further attention or minimal maintenance to exclude further larval development.

The elimination or routine draining of water holding containers excludes them as a regular source of mosquito development. The tire recycling program typically offered by the RDCO every fall collects an average of 1400 – 1600 tires annually. Uncovered tires or boats stored outdoors, or tarped wood piles or equipment can hold rainwater and leaves, heat up quickly in the sun, and provide perfect habitat for mosquitos to develop, particularly *Culex* mosquitos, many species of which are vectors of WNv. When these types of habitat are observed by *Duka Ltd.* field personnel they are brought to the attention of the property owner, manager or resident for possible action.

Removal or alteration of mosquito producing habitat does not necessarily mean drainage resulting in habitat destruction for other organisms and natural predators. For sloughs, water features and irrigation ponds at golf courses and private properties where site elimination is not desirable for aesthetic or practical reasons, measures include installing fountains, water baffles or pumps to increase water movement. Moving water reduces a site's suitability for larval mosquito development while conserving, and enhancing, habitat for aquatic (insect, fish, amphibian) mosquito predators. Nearly all the local golf courses have some form of water agitation in one or more of their ponds. Development where it occurs, tends to be in vegetated (cattails, grasses, brush) sloughs, ditches or pond edges which are protected from water movement.

Given that physical elimination of most natural or purpose-designed manmade open water mosquito development habitats occurring within the area is impractical or undesirable, developing mosquito populations are best controlled using bio-rational larvicides containing *Bacillus thuringiensis* var. *israelensis* (VectoBac 200G) or *Bacillus sphaericus* (VectoLex CG or WSP). Their use supports the principles of an Integrated Pest Management (IPM) approach to mosquito control.

The procedures, methodologies, and control products employed in this annual program are described in detail in the *Regional District of Central Okanagan Mosquito Control Pest Management Plan (PMP) # 142-0030-21/26*. The PMP expires on 03 March 2026.

All government regulatory agency conditions and notifications were completed as required for program start-up and operation by *Duka Ltd*, as appropriate. BCMOE requisite reporting, the "*Pesticide Use Follow-up Report*" (due 31 December 2024) and the "*Annual Report on Pesticide Use for Confirmation Holders*" (January 2024) will be completed by *Duka Ltd*. and submitted to the BCMOE on behalf of the RDCO.

5.4 West Nile virus and Zika virus Update

- ***West Nile Virus***

Due to the low and stable incidence of West Nile virus (WNv) it was decided by the BCCDC in the fall of 2014 that it was no longer necessary to conduct active surveillance of mosquitos or other indicators. The provincial decision to eliminate this surveillance was reached at the BC Communicable Disease Policy Advisory Committee meeting in February 2015. Since 2015, WNv surveillance in BC has been conducted through testing horses, birds that are sick or dead, and humans who have symptoms compatible with WNv. Human clinical testing continues as part of routine blood and organ donor programs. Health Canada relies on the provinces and territories to report the number of West Nile virus cases.

One travel related case of WNv was reported in BC at the end of August 2024. A single case of WNv was reported in BC during September 2023, also likely related to travel out of province. In 2021 two travel-related human cases were reported in BC and no animals tested positive for WNv. No humans or animals tested positive in 2022 and 2020 for WNv in BC. In 2019 one-travel-related human case and one travel-related horse case were reported. A human case of WNv originating within B.C. has not been reported since 2017, (bccdc.ca/health-info/diseases-conditions/west-nile-virus-wnv).

- ***Zika (ZIKV) virus***

Zika virus disease is a mosquito-associated flaviviral disease caused by Zika virus (ZIKV). It is related to other *Flaviviridae,* including Japanese Encephalitis, West Nile, Yellow Fever, St. Louis Encephalitis and Dengue viruses. Provincial and national resources are continually being developed and compiled for health care professionals to reference. Guidance documents for health care professionals and travelers

are regularly updated as information on Zika virus becomes available, (bccdc.ca/health-info/diseasesconditions/zika-virus).

As part of West Nile virus surveillance programs, several provinces and territories continue to conduct routine mosquito surveillance activities. Provinces, Regional Districts and Municipalities are responsible for the control of mosquito populations. Health Canada advises that in the future, consideration could be given to enhancing mosquito surveillance to detect an incursion of new or invasive mosquito species in Canada. This would include those species responsible for Zika virus transmission. The mosquito species which carry Zika virus are not present in Canada.

6.0 REFERENCES AND LITERATURE REVIEWED

BC Centre for Disease Control, 2004. *Arbovirus Surveillance and Response Guidelines for British Columbia. www.BCCDC.org*

BC Centre for Disease Control, 2008. *BC WNv Mosquito Control Working Group. excerpt*: BC provincial *Mosquito Pest Management Plan, July 03, 2008.*

BC Centre for Disease Control, 29 May 2015. Email from Marsha Taylor, Epidemiologist, BCCDC to *DGRA Ltd*. Status update.

BC Centre for Disease Control. West Nile virus reports, updates etc. (*www.BCCDC.ca*)

B.C. Ministry of Agriculture and Food. *Mosquito Control Guide.* Queens Printer, Victoria, 1984.

BC Ministry of Environment, Winter snowpack (snow pillow) accumulations (River Forecast Centre, www.env.gov.bc.ca/rfc/)

Belton, Peter. *The Mosquitoes of British Columbia.* Victoria: Handbook (British Columbia Provincial Museum) No 41, 1983, 189 pages. www.sfu.ca/~belton/. Various and ongoing updates, 2005 -2008.

Darsie, R. and Ward, R., 1981. *Identification and Geographical Distribution of the Mosquitoes of North America, North Mexico*, American Mosquito Control Association, 313pp.

DG Regan and Associates Ltd. *Regional District of Central Okanagan Integrated Pest Management Plan PMP # 142-0028-16/21, Mosquito Control Program.* Expiry 03 May 2021

DG Regan and Associates Ltd., *Regional District of Central Okanagan Nuisance and Vector Mosquito Control Program Summary Report.* November 2016, 24 pages.

Duka Environmental Services Ltd., Regional District of Central Okanagan Nuisance and Vector Mosquito Surveillance and Control Program Summary Reports. 2017-2023.

Duka Environmental Services Ltd. Regional District of Central Okanagan Integrated Pest Management Plan PMP # 142-0030-21/26, Mosquito Control Program. Expiry 03 March 2026

Ellis, Roy., Municipal *Mosquito Control Guidelines,* Health Canada Bureau of Infectious Diseases, 54 pages, 2005.

Environment Canada, http://climate.weatheroffice.ec.gc.ca/climateData/dailydata

Fang, Janet. 2010. Ecology. A World without Mosquitos. Nature 466: 432-434

Gonsalves, Leroy., Brian Bicknell, Brad Law, Cameron Webb & Vaughn Monamy. 2013. Mosquito Consumption by insectivorous bats. Does Size Matter. PloS one 8 (10) 00; e77183

Google Maps™ and Google Earth™.

Health Canada. West Nile and Zika (ZIKV) reports, updates, travel advisories, etc. (www.Hc-sc.gc.ca)

Lacey, L.A., M.S. Mulla. *Safety of Bacillus thuringiensis ssp. israelensis and Bacillus sphaericus to Nontarget Organisms in the Aquatic Environment.* 1988, 19 pp.

Toronto Star, 19 February 2016. News story. Ms. Fiona Hunter, Brock University, St. Catharines, Ontario.

Valent BioSciences. www.valentbiosciences.com

Wood, D.M., Dang, P.T., Ellis, R.A., 1979. *The Insects and Arachnids of Canada; Part 6, Diptera; Culicidae.* Canadian Government Publishing Centre, Ottawa, 390pp.

TABLES

Table 1: **Vectobac 200G Application Summary; Regional District of Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
AP	**Airport Kelowna**			
AP		4	0.207	1.55
AP02	Unit 1-395 Hereron Rd	10	5.707	42.80
AP03	Hereron Rd	4	0.293	2.20
AP05	3510 Bulman Rd	9	0.880	6.60
AP06	1137 Alumni Ave	5	0.107	0.80
AP07A	3740 Bulman Rd Mill Creek (wetland/ponds)	5	0.207	1.55
AP07B	3740 Bulman Rd Mill Creek (wetland/ponds)	4	0.307	2.30
AP07C	3740 Bulman Rd Mill Creek (wetland/ponds)	10	1.067	8.00
AP08	3685 Bulman Rd	2	0.253	1.90
AP10	5720 Upper Booth Rd N	1	0.400	3.00
AP12	4520 Farmers Dr.	5	0.113	0.85
AP16B	6880 Sierra Dr	4	0.253	1.90
AP21A	2210 Quail Ridge Blvd	3	0.827	6.20
AP21B	2210 Quail Ridge Blvd	3	0.387	2.90
AP22	2210 Quail Ridge Blvd	5	0.387	2.90
AP24	3200 Via Centrale	4	0.071	0.53
AP25	Quail Crescent	10	0.547	4.10
AP26	Valentino Crt	2	0.180	1.35
AP29	5225 Highway 97 North	2	0.267	2.00
AP30	Adams Rd & Carnie Rd	3	0.093	0.70
AP34	Bulman Road Next to pullout by bikepath	1	0.133	1.00
AP35B	6741 Hwy 97 North	2	0.440	3.30
AP37	5932 Old Vernon Road	7	0.240	1.80
AP38	2725 Acland Rd	3	0.173	1.30
	Airport totals	**108**	**13.537 ha**	**101.53 kg**
DK	**Downtown Kelowna**			
DK01	Francis Ave off Pandosy	6	0.653	4.90
DK02A	Sunset Dr	4	0.040	0.30
DK02B	Sunset Dr	2	0.033	0.25
DK05	Knox Mountain Dr	2	0.627	4.70
DK06	Rio Dr	3	0.067	0.50
	Downtown totals	**17**	**1.420 ha**	**10.65 kg**

Table 1: **Vectobac 200G Application Summary; Regional District of Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
GG	**Gallagher**			
GG		7	0.000	7.28
GG01	4320 Gallaghers Dr West	7	0.000	1.65
GG02	4320 Gallaghers Dr West	3	0.040	0.30
GG05	4075 Jean Rd	5	0.331	2.48
GG06	3295 Mathews Rd	2	0.070	0.53
GG07	4284 Jaud Rd	4	0.200	1.50
GG08	4205 Wallace Hill Rd	2	0.087	0.65
GG10A	2950 Balldock Rd	3	0.087	0.65
GG10B	2950 Balldock Rd	4	0.127	0.95
GG10C	2950 Balldock Rd	3	0.087	0.65
GG13	3079/3081 Hall Rd	4	0.087	0.65
GG16	Across from 3129 Hall Rd	5	0.427	3.20
GG17	3145 Hall Rd, 2550 & 2570 Maquinna Rd	4	0.267	2.00
GG20A	3130 Hall Rd	3	0.100	0.75
GG20B	3130 Hall Rd	3	0.093	0.70
GG21	2455 Maquinna Rd & 2475 Maquinna Rd	6	0.627	4.70
GG22B	3150 Hall Rd	6	0.293	2.20
GG23	3190 Hall Rd	7	0.404	3.03
GG24	3215 Hall Rd	3	0.120	0.90
GG25A	3236 Hall Rd	6	0.200	1.50
GG25B	3236 Hall Rd	7	0.860	6.45
GG26	2415 Dunsmuir Rd	6	0.307	2.30
GG27	3205 Wildwood Rd	5	0.160	1.20
GG29A	2130 K.L.O. Rd	2	0.093	0.70
GG29B	2130 K.L.O. Rd	6	1.347	10.10
GG30A	1979 K.L.O. Rd	2	0.060	0.45
GG30B	1979 K.L.O. Rd	3	0.060	0.45
GG31	3195 Hall Rd	5	0.093	0.70
GG32	3270 Wildwood Dr	4	0.260	1.95
GG33	3280 Wildwood Dr	3	0.200	1.50
GG34A	3281 Hall Rd	4	0.107	0.80
GG34B	3281 Hall Rd	2	0.040	0.30
GG34C	3281 Hall Rd	6	0.313	2.35
GG36	3236 Hall Rd	6	0.147	1.10

Table 1: **Vectobac 200G Application Summary; Regional District of Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
GG37A	3040 Hall Rd	5	0.267	2.00
GG38	3314 Wildwood Rd.	6	0.447	3.35
GG39A	1959 KLO Rd	2	0.107	0.80
GG39B	1959 KLO Rd	2	0.127	0.95
GG39C	1959 KLO Rd	4	0.247	1.85
GG39D	1959 KLO Rd	4	0.287	2.15
GG39E	1959 KLO Rd	5	0.253	1.90
GG39F	1959 KLO Rd	4	0.127	0.95
GG42	4615 June Springs Rd	4	0.120	0.90
GG44	4154 Gallagher's Forest South	1	0.007	0.05
GG45	2450 Maquinna Rd	6	0.800	6.00
GG46	3523 Hall Rd	3	0.040	0.30
	Gallagher totals	**194**	**10.518 ha**	**87.81 kg**
GM	**Glenmore**			
GM01	4055 North Glenmore Rd	4	0.260	1.95
GM02	3550 North Glenmore Rd	2	0.040	0.30
GM03	3550 North Glenmore Rd	6	0.180	1.35
GM04	2248 McKinley Rd	1	0.020	0.15
GM07A	2105 North Glenmore Rd	5	0.540	4.05
GM07B	2105 North Glenmore Rd	13	3.007	22.55
GM07C	2105 North Glenmore Rd	4	0.140	1.05
GM08A	Millard Crt West	1	0.040	0.30
GM10	John Hindle Dr & Landfill Entrance Rd	13	1.880	14.10
GM13	Glenmore, Sth of Begbie, ditches on westside	2	0.200	1.50
GM19A	2105 North Glenmore Rd	14	3.727	27.95
GM19B	2105 North Glenmore Rd	9	0.441	3.31
GM19C	2105 North Glenmore Rd	11	0.720	5.40
GM19E	2105 North Glenmore Rd	10	0.675	5.06
GM19F	2105 North Glenmore Rd	4	0.040	0.30
GM19G	2105 North Glenmore Rd	1	0.013	0.10
GM19I	2105 North Glenmore Rd	13	1.713	12.85
GM19J	2105 North Glenmore Rd	1	0.040	0.30
GM22A	Curtis Rd & Sexsmith Rd	3	0.387	2.90

Table 1: **Vectobac 200G Application Summary; Regional District of Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
GM22B	649 Curtis Rd across street	5	1.613	12.10
GM22D	899 Curtis Rd	6	1.027	7.70
GM22E	John Hindle Dr & Landfill Entrance Rd	11	2.420	18.15
GM22F	959 Curtis Rd	5	0.693	5.20
GM22G	989 Curtis Rd	5	0.387	2.90
GM22H	995 Curtis Rd	4	0.333	2.50
GM22I	1019 Curtis Rd	4	0.727	5.45
GM26	Hilltown Dr, McKinley Beach pond	4	0.607	4.55
	Glenmore totals	**161**	**21.869 ha**	**164.02 kg**
GMHL	**Glenmore Highlands**			
GMHL02	Upper Canyon Dr & Union Rd	3	0.200	1.50
GMHL03A	Longridge Dr & Hidden Lake Pl	3	0.213	1.60
GMHL03B	Longridge Dr & Hidden Lake Pl	2	0.080	0.60
	Glenmore Highlands totals	**8**	**0.493 ha**	**3.70 kg**
MIS	**Mission**			
MIS		4	0.400	3.00
MIS01	3330 Wildwood Road	1	0.001	0.01
MIS03	3687 Benvoulin	4	0.141	1.06
MIS07	3805 Lakeshore Rd	10	1.333	10.00
MIS08A	4105 Gordon Drive	5	0.540	4.05
MIS08B	4105 Gordon Drive	3	0.100	0.75
MIS10A	1085 Lexington Ave	6	0.653	4.90
MIS10C	1085 Lexington Ave	4	0.073	0.55
MIS10E	1085 Lexington Ave	1	0.007	0.05
MIS10F	1085 Lexington Ave	1	0.027	0.20
MIS11	3854 Gordon Dr	4	0.227	1.70
MIS12	4444 Belmont Road	8	0.707	5.30
MIS13A	3885 Gordon Drive	5	0.207	1.55
MIS13B	3885 Gordon Drive	8	3.447	25.85
MIS13C	3885 Gordon Drive	10	2.587	19.40
MIS14	Munson Road Off Benvoulin Road	2	0.133	1.00
MIS15A	1429 K.L.O. Rd	3	0.153	1.15

Table 1: **Vectobac 200G Application Summary; Regional District of Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
MIS15B	1394 Ladner Road	1	0.020	0.15
MIS17	K.L.O. Road	4	0.280	2.10
MIS18A	Casorso Road & Mission Creek Bridge	7	0.447	3.35
MIS18B	Casorso Road & Mission Creek Bridge	9	0.507	3.80
MIS18C	Casorso Road & Mission Creek Bridge	8	2.240	16.80
MIS18D	Casorso Road & Mission Creek Bridge	3	0.133	1.00
MIS18F	Site Number Not Found	1	0.033	0.25
MIS19	2077 Fisher Rd	5	0.200	1.50
MIS21A	Swamp Road	8	0.647	4.85
MIS21B	Swamp Road	1	0.020	0.15
MIS22	3695 Benvoulin Rd	9	1.520	11.40
MIS23	3685 Benvoulin Rd	8	1.027	7.70
MIS26	449 Cavell Place	2	0.016	0.12
MIS29	5010 South Ridge Drive - Corner Of Southridge Dri	2	0.253	1.90
MIS31A	5145 Gordon Drive	1	0.213	1.60
MIS31C	Steele Road & Twinflower Crescent	2	0.033	0.25
MIS32	722 S Crest Drive	1	0.005	0.04
MIS34	2500 Enterprise Way	4	0.547	4.10
MIS35	Mayer Road	4	0.207	1.55
MIS36	1750 Munson Road	8	0.320	2.40
MIS37	3551 Benvoulin Road	6	1.067	8.00
MIS38	Rockview Park; Rockview Lane	5	0.490	3.68
MIS39	3155 Gordon Drive	2	0.053	0.40
MIS40	410 Providence Avenue	3	0.253	1.90
MIS43	992 Grenfell Court	1	0.013	0.10
MIS49A	3830 Casoro Road	4	0.047	0.35
MIS50A	1321 Ladner Road	6	0.337	2.53
MIS50B	1321 Ladner Road	7	1.480	11.10
MIS50D	Site Number Not Found	1	0.013	0.10
MIS51	Fascieux Wetlands	7	0.360	2.70
MIS54	3750 Casoro Road	1	0.007	0.05
MIS56A	1590 Pioneer Road	6	1.187	8.90
MIS56B	1590 Pioneer Road	6	1.060	7.95
MIS57	1524 Pioneer Road	2	0.060	0.45
MIS58	3260 Gordon Drive	1	0.020	0.15

Table 1: **Vectobac 200G Application Summary; Regional District of Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
MIS59	1456 KLO Road	1	0.003	0.03
	Mission totals	**226**	**25.855 ha**	**193.91 kg**
RT	**Rutland**			
RT		3	0.093	0.70
RT03A	Corner Of Hwy 33 & Black Mountain Drive	2	0.107	0.80
RT04A	Off Hwy 33 And Joe Rich Road	3	0.049	0.37
RT05	1755 Gallaghers Road	1	0.040	0.30
RT06	1784 Loseth Rd	6	0.455	3.41
RT07	1759 Hwy 33 East	4	0.193	1.45
RT08	1205 Montenegro Drive	2	0.093	0.70
RT10A	2050 Treetop Road	2	0.060	0.45
RT10B	2050 Treetop Road	4	0.153	1.15
RT14	245 Cornish Rd, Beside Driveway	1	0.013	0.10
RT15	488 Moyer Rd	1	0.033	0.25
RT16	1164 Morrison Rd	2	0.047	0.35
RT19	250 Sumac Rd W	6	0.783	5.88
RT21	Off Hollywood Road South	5	0.547	4.10
RT22A	Leckie Rd & Springfield	1	0.053	0.40
RT22B	Leckie Rd & Springfield	2	0.033	0.25
RT22C	Leckie Rd & Springfield	3	0.040	0.30
RT22D	Leckie Rd & Springfield	2	0.027	0.20
RT25A	Fenwick Rd	3	0.060	0.45
RT25B	Fenwick Rd	1	0.013	0.10
RT25C	Fenwick Rd	4	0.200	1.50
RT25D	Fenwick Rd	1	0.020	0.15
RT27B	1855 Tower Ranch Boulevard	2	0.020	0.15
RT27C	1855 Tower Ranch Boulevard	1	0.007	0.05
RT28	1225 Mackenzie Road	6	0.227	1.70
RT30	2602 Joe Riche Road	2	0.073	0.55
RT32	175 Rains Road	5	0.173	1.30
	Rutland totals	**75**	**3.521 ha**	**27.11 kg**

Table 1: **Vectobac 200G Application Summary; Regional District of Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
WO	**Winfield-Oyama (Lake Country)**			
WO01	2611 Stillwater Way	5	0.413	3.10
WO03	8824 Hwy 97	2	0.013	0.10
WO04	10639 Bottom Wood Lake Rd	9	0.210	1.58
WO07	10639 Bottom Wood Lake Rd	5	0.160	1.20
WO08	Lodge Rd	2	0.053	0.40
WO12	Lodge & Woodsdale Rd	3	0.113	0.85
WO13A	3687 Woodsdale Rd	4	0.293	2.20
WO13C	3583 Woodsdale Rd	1	0.001	0.01
WO17	4404 Hebbert Rd	2	0.147	1.10
WO18A	12250 Oyama Rd	8	0.340	2.55
WO20A	5574 Hayton Rd	6	0.187	1.40
WO20B	5574 Hayton Rd	9	0.537	4.03
WO24	15800 Oyama Rd	2	0.053	0.40
WO25	15800 Oyama Rd	1	0.007	0.05
WO27	3271 Berry Rd	10	0.473	3.55
WO31	4108 Evans Rd	3	0.107	0.80
WO32	16811 Owls Nest Rd North pond	2	0.560	4.20
WO35	1960 Camp Rd	7	0.597	4.48
WO36	1960 Camp Rd	11	1.433	10.75
WO37	Long Rd Pond	9	0.269	2.02
WO39	2975 Woodsdale Rd at corner of Woodsdale Ct	9	0.248	1.86
WO41A	12824 Oyama Rd	8	0.487	3.65
WO43	13221 Cliffstone Rd	5	0.253	1.90
WO48	McCoubrey & Okanagan Centre Rd	3	0.023	0.17
WO51	9750 Seaton Rd	3	0.007	0.05
WO54	3583 Woodsdale Rd	5	0.087	0.65
	Winfield-Oyama totals	**134**	**7.072 ha**	**53.04 kg**
	Treatment (Vectobac 200G) Totals	**923**	**84.285 ha**	**641.77 kg**

Table 2: **Vectobac 200G Application Summary; Regional District Central Okanagan - Westbank First Nations; 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
WFN02A	Lindley Dr	1	0.007	0.05
WFN03	Daimler Dr & Ross Rd	3	0.080	0.60
WFN04B	3509 Carrington Rd	6	0.213	1.60
WFN04C	3509 Carrington Rd	1	0.013	0.10
WFN04E	3509 Carrington Rd	8	0.367	2.75
WFN04F	3509 Carrington Rd	11	0.647	4.85
WFN04G	3509 Carrington Rd	7	0.200	1.50
WFN04H	3509 Carrington Rd	6	0.187	1.40
WFN04I	3509 Carrington Rd	4	0.153	1.15
WFN06	Bering Rd & Louie Dr	**4**	0.180	**1.35**
WFN07	3041 Louie Dr	3	0.147	1.10
WFN09	Bering Rd & Carrington Rd	4	0.173	1.30
WFN12	~1860 Boucherie Rd	2	0.020	0.15
WFN13	3210 Shannon Lake Rd	1	0.080	0.60
WFN13	Grouse Rd	6	0.153	0.65
WFN	Wolfe Rd	4	0.153	0.30
	Total Applications	**71**	**2.773 ha**	**19.45 kg**

Table 3: **VectoLex WSP (10g satchels) Application Summary; Regional District Central Okanagan; Kelowna, 2024 Nuisance and Vector Mosquito Surveillance and Control Program**

Site #	Location	# of Treatments	Area Size (ha)	Amount Applied (kg)
AP05	3510 Bulman Rd	1	0.040	0.3
AP06	1137 Alumni Ave	1	0.027	0.2
AP07C	3740 Bulman Rd Mill Creek (wetland/ponds)	1	0.027	0.20
AP25	Quail Crescent	1	0.013	0.10
GG17	3145 Hall Rd, 2570 Maquinna Rd, 2550 Maquinna Rd	1	0.004	0.03
GG22B	3150 Hall Road	1	0.004	0.03
GG24	3215 Hall Rd	1	0.003	0.02
GG26	2415 Dunsmuir Rd,	1	0.004	0.03
MIS08A	4105 Gordon Drive	1	0.080	0.6
MIS08B	4105 Gordon Drive	1	0.004	0.03
MIS10A	1085 Lexington Ave	1	0.004	0.03
MIS13C	3885 Gordon Drive	1	0.005	0.04
MIS15A	1429 K.L.O. Rd	1	0.001	0.01
MIS15B	1394 Ladner Road	2	0.008	0.06
MIS26	449 Cavell Place	1	0.005	0.04
RT03A	Corner Of Hwy 33 & Black Mountain Drive	2	0.007	0.05
WO04	10639 Bottom Wood Lake Rd	1	0.013	0.1
WO07	10639 Bottom Wood Lake Rd	1	0.013	0.1
WO13A	3687 Woodsdale Road	1	0.013	0.1
WO18A	12250 Oyama Road	1	0.013	0.1
WO27	3271 Berry Road	1	0.013	0.1
WO35	1960 Camp Road	1	0.004	0.03
WO36	1960 Camp Road	1	0.007	0.05
WO37	Long Road	2	0.016	0.12
WO41A	12824 Oyama Road,	1	0.027	0.2
WO43	13221 Cliffstone Court	1	0.013	0.1
WO54	12390 Oyama Rd	1	0.013	0.1
		30	**0.382 ha**	**2.87 kg**