RESISTANCE TO SCOURGE® INSECTICIDE IN THE MOSQUITO POPULATIONS OF FOUR TOWNS IN THE CENTRAL MASS. MOSQUITO CONTROL PROJECT SERVICE AREA: WESTBOROUGH, BILLERICA, TEWKSBURY, AND WILMINGTON

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ABSTRACT

The Central Massachusetts Mosquito Control Project (CMMCP) has been using a synthetic pyrethroid called resmethrin, trade name Scourge®, since the early 1990's to control adult mosquito populations in its service area. The current CMMCP policy is to accept service requests from residents and town officials for adult mosquito control and to perform limited, targeted applications, and not perform random, area-wide spraying as was the standard procedure for adult mosquito control in Massachusetts decades ago. As part of our Standard Operating Procedures manual and as a function of an Integrated Mosquito Management (IMM) plan, surveillance is analyzed before any product is applied to justify the application. This can be in the form of landing rate counts or data collected from mosquito traps. Resistance to a class of chemicals has been noted in other areas of the world, and we will attempt to determine if any mosquito species or any collections of mosquitoes from a given area will show resistance to the synthetic pyrethroid class of chemicals. If resistance is noted, this may affect the product choice for vector-borne disease control, as well as the reduction of nuisance levels of mosquitoes. Initial results from 2005 show a minor potential for resistance, but no change in product usage is recommended at this time. There is no indication that resistance levels will increase due to the limited, sporadic nature of the CMMCP adulticide program, but further study would be prudent.

INTRODUCTION

The purpose of this study was to determine whether or not resistance to resmethrin was developing in the mosquito populations at the most frequently sprayed properties. If significant resistance were present, it could necessitate changing from resmethrin to a different product registered in Massachusetts and accepted by the Centers for Disease Control (CDC) for mosquito control. This would be particularly important in the case of an outbreak of mosquito-borne diseases such as West Nile Virus (WNV) or Eastern Equine Encephalitis (EEE). If a particular species of mosquito or a mosquito collection from a given area has been shown to be resistant to the pyrethroid class of chemicals, then vector suppression may need to be done using different products and procedures. The towns of Westborough, Billerica, Tewksbury and Wilmington were chosen for the study because these are the only towns in the CMMCP service area where WNV or EEE have been found either in mosquitoes, horses or humans. WNV was found in a collection of mosquitoes in Westborough in 2003, and that same year a woman in the area of the virus positive mosquito also contracted WNV. Horses in Billerica and Wilmington were identified to have been infected with EEE in 2004, and mosquitoes positive for EEE were found in Tewksbury in 2002.

METHODS AND MATERIALS

Five study sites were chosen in each town, from among the most frequently sprayed properties in the town according to the CMMCP database of service requests. The frequency of spraying was determined from a database of spray requests from 1998 to the present. Because the towns vary in their overall mosquito population and the number of requests is determined by the property owners, no two sites had exactly the same number of requests in each season. The number of spray requests varied considerably. The most frequently sprayed property had been sprayed 38 times over the eight year period, while the least frequently sprayed property had only been sprayed four times, all in 2004. Most of the properties had been sprayed between 12 and 25 times since 1998. All but two of the properties were at private homes; one was a public recreational area, and another was a wetland area at the end of a cul-de-sac. The cul-de-sac site was chosen because at that site mosquitoes had been found to be positive for West Nile in 2003 and this was in the neighborhood of the human WNV case in 2003.

A control site was chosen in the town of Westborough in a swamp bordering an organic farm. This site has never been sprayed for mosquitoes by CMMCP, and to the best of our knowledge the town and the property owners did not apply any insecticides in that area. It was presumed that mosquitoes from this site would have no resistance to resmethrin having never been exposed to any insecticides.

At each site, live adult mosquitoes were collected using two CDC-style traps (John W. Hock Company) baited with carbon dioxide at 20 psi. The traps were set early in the morning and collected the following morning. Traps were set for one or two nights, depending on how many mosquitoes were collected. The number of mosquitoes tested for each site varied from 30 to 152; for most sites it was approximately 50.

The resistance testing was conducted according to the bottle bioassay procedure described by Brogdon and McAllister[1]. Scourge® insecticide (18% Resmethrin + 54% piperonyl butoxide synergist, lot no. 465-0815) manufactured by Bayer Environmental Science Company was diluted in acetone to make a 0.005% solution, and was evenly applied to coat the insides of 250ml Wheaton bottles (Fisher Scientific Company). Each bottle was coated with 1ml of acetone and 1ml of Scourge solution, containing 9.05 μg of resmethrin and 27.02 μg of piperonyl butoxide. This dosage was determined by testing seven batches of mosquitoes from the control site with Scourge/acetone solutions of different strengths. Controls consisted of bottles coated only with acetone.

After the mosquitoes were aspirated from the trap cage and introduced into the coated bottles, each bottle was checked at five-minute intervals, and the number of mosquitoes knocked down was recorded. A mosquito was considered knocked down if it could not regain a standing position when knocked off its feet by gently tapping or shaking the bottle. Knock-down was chosen as the standard rather than overall mortality because resmethrin may cause the mosquitoes to twitch even after they are dead, making the time of death difficult to determine exactly.

RESULTS

No mosquitoes were knocked down in the acetone-only control bottles. The mosquitoes from the unsprayed control site were all knocked down within ten minutes, with 96% knocked down after only five minutes.

The mosquitoes from the recreational area site survived the longest, reaching 100% knocked down only at 35 minutes. At one other site, 100% were knocked down at 25 minutes. At twelve sites, 100% were knocked down at 20 minutes, and at six sites, 100% were knocked down at 15 minutes. Sample graphs are included in this presentation, and all data is available on the CMMCP website at http://www.cmmcp.org/2005resistance.htm.

DISCUSSION AND CONCLUSIONS

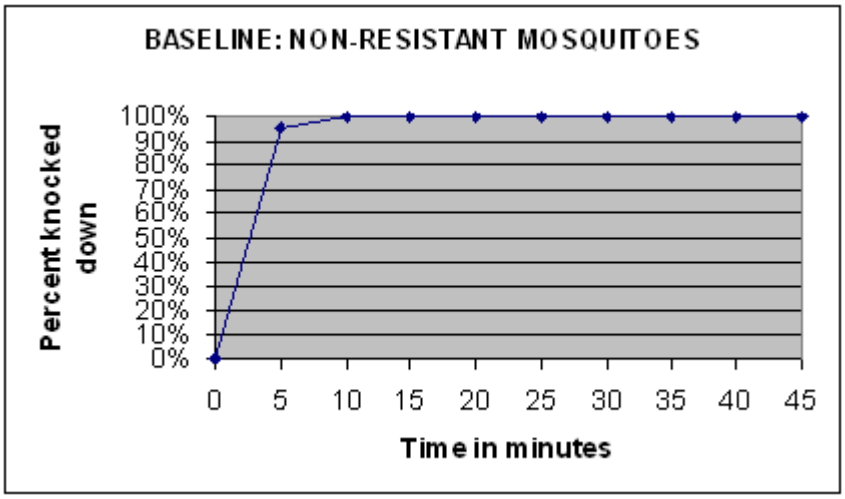
At all of the study sites, the mosquitoes survived longer than those from the control site. The majority of the samples contained some individual mosquitoes that survived at least twice as long as the control mosquitoes. This would seem to indicate that some resistance to resmethrin may be developing in the populations surveyed.

However, another bottle bioassay study of resistance to various insecticides, including resmethrin, found resistant mosquitoes surviving for up to three hours.[2] In comparison, mosquitoes that survive for 20 to 35 minutes do not seem to be very resistant to resmethrin. If resistance is developing in the CMMCP service area, it appears to be at an early stage. A change of insecticide is not recommended at this time, although continued monitoring of resistance would be a wise course of action. Greater resistance could develop at a later date.

REFERENCES

1. Brogdon WG and McAllister JC. Simplification of adult mosquito bioassays through use of time-mortality determinations in glass bottles. J Am Mosq Control Assoc 14:159-164 (1998).

2. McAbee RD, Kang KD, Stanich MA, et al. Pyrethroid tolerance in *Culex pipiens pipiens* var *molestus* from Marin County, California. Pest Manag Sci 60:359-368 (2003).


BASELINE: NON-RESISTANT MOSQUITOES
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
Time in minutes


ACETONE ONLY: NO RESMETHRIN
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
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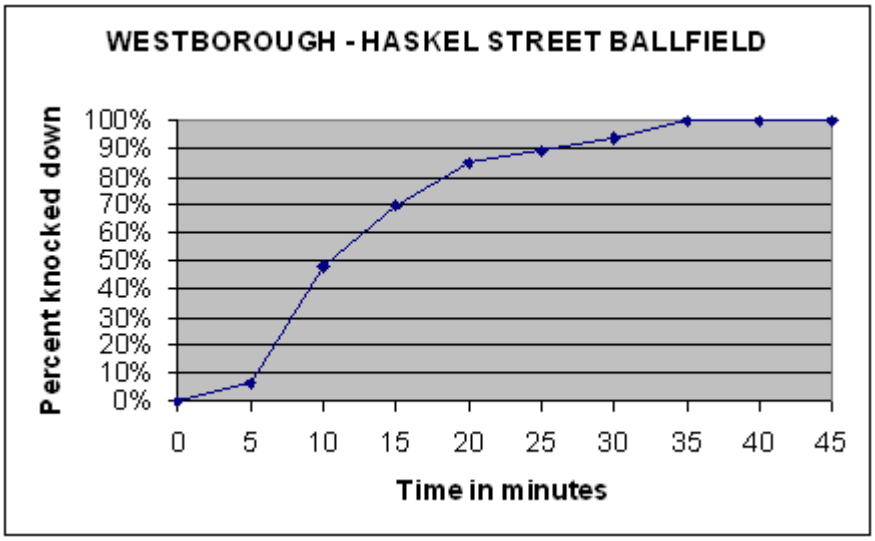
Time in minutes


WESTBOROUGH - HASKEL STREET BALLFIELD
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5
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15
20
25
30
35
40
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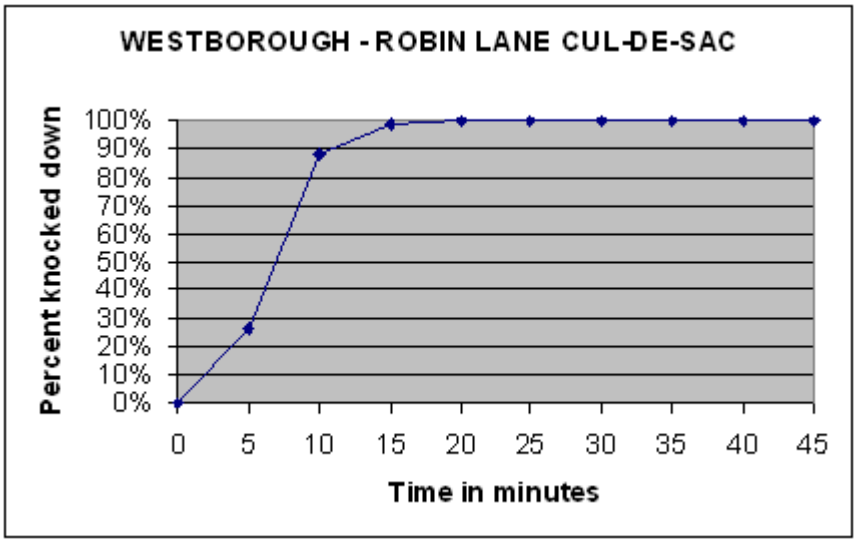
Time in minutes


WESTBOROUGH - ROBIN LANE CUL-DE-SAC
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
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25
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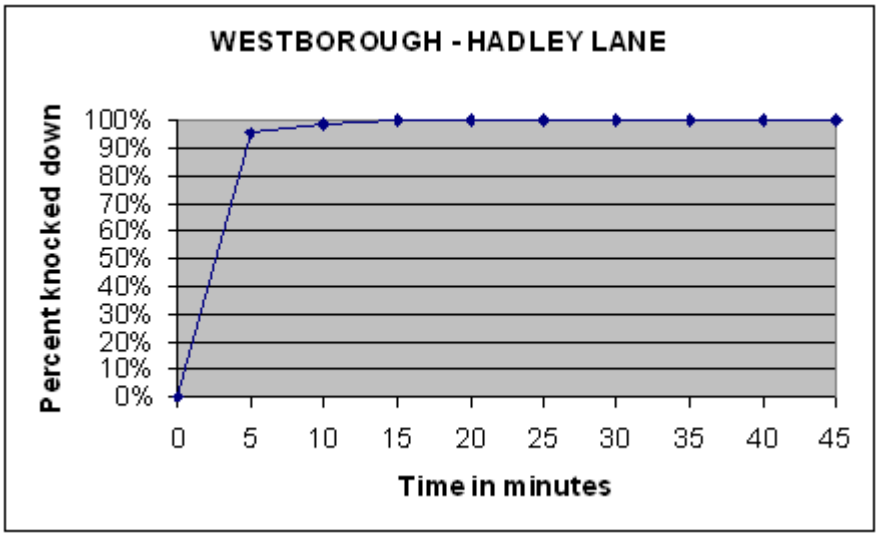
Time in minutes


WESTBOROUGH - HADLEY LANE
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
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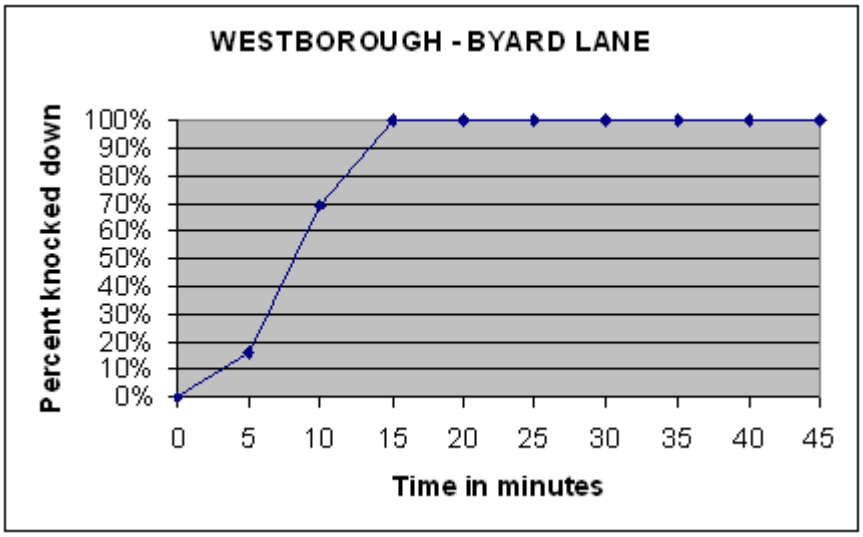
Time in minutes


WESTBOROUGH - BYARD LANE
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
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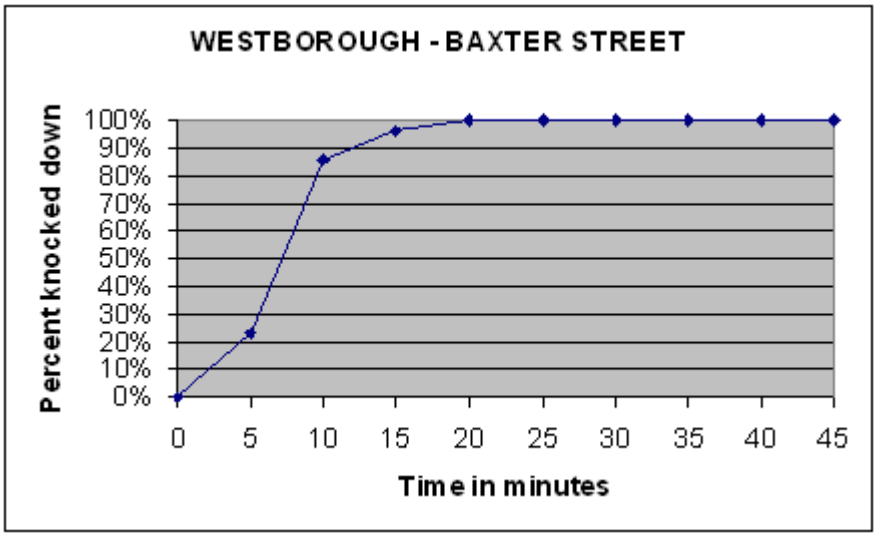
Time in minutes


WESTBOROUGH - BAXTER STREET
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
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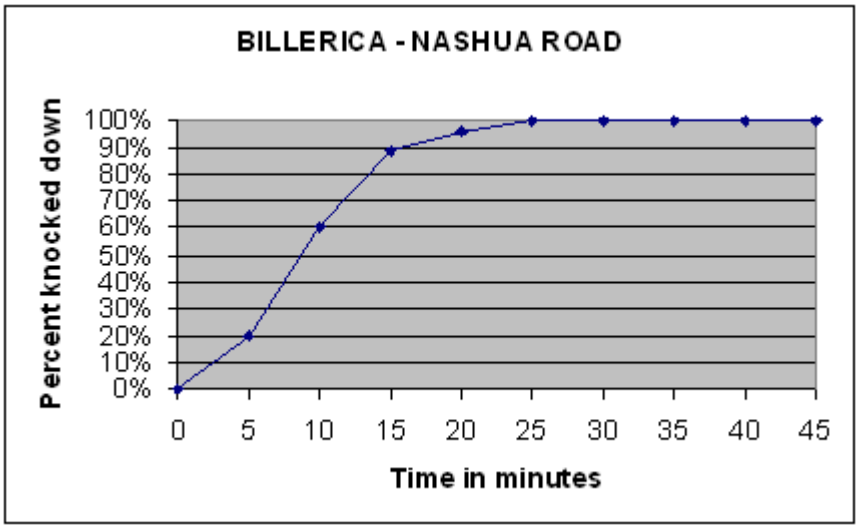
Time in minutes


BILLERICA - NASHUA ROAD
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5
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25
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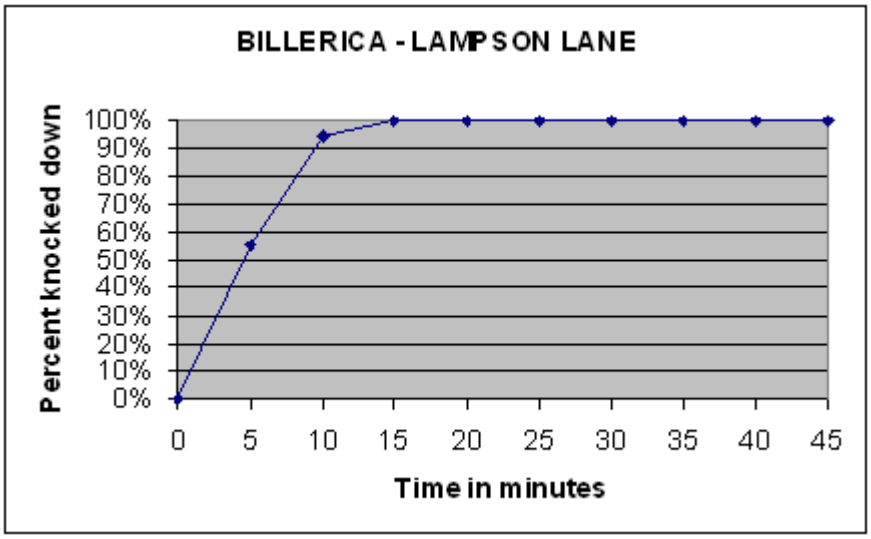
Time in minutes


BILLERICA - LAMPSON LANE
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
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40
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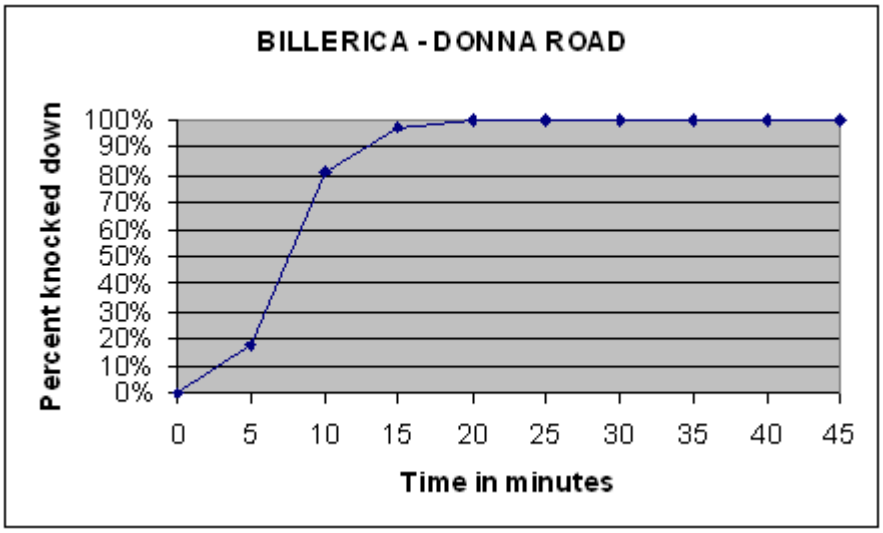
Time in minutes


BILLERICA - DONNA ROAD
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
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40
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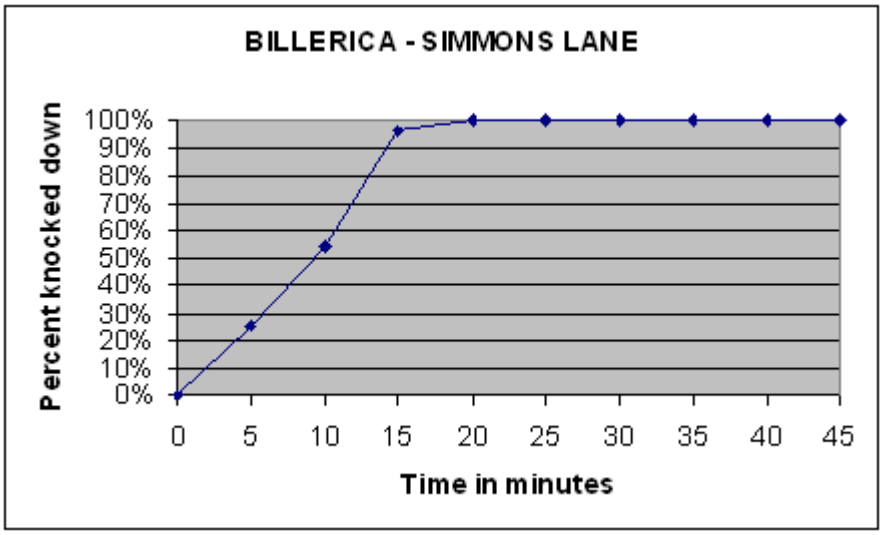
Time in minutes


BILLERICA - SIMMONS LANE
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
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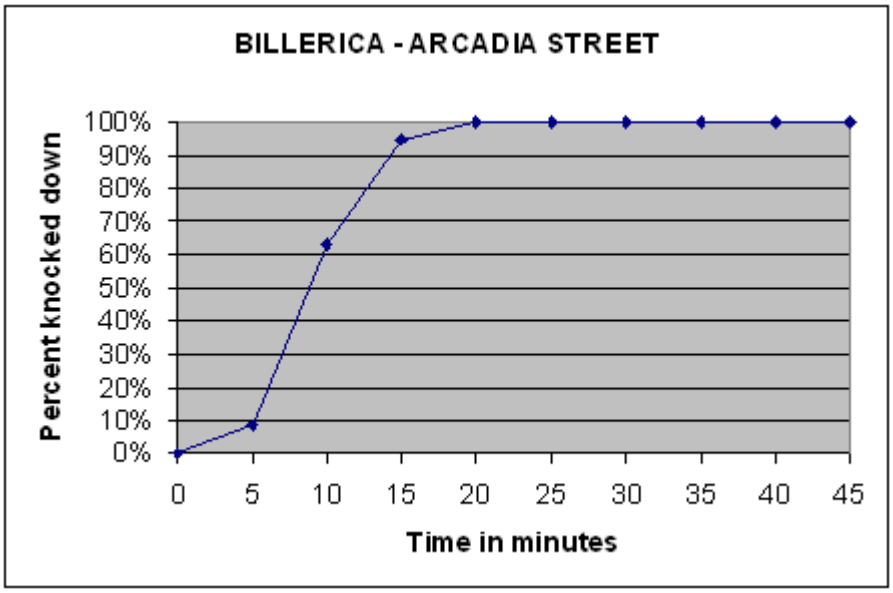
Time in minutes


BILLERICA - ARCADIA STREET
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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5
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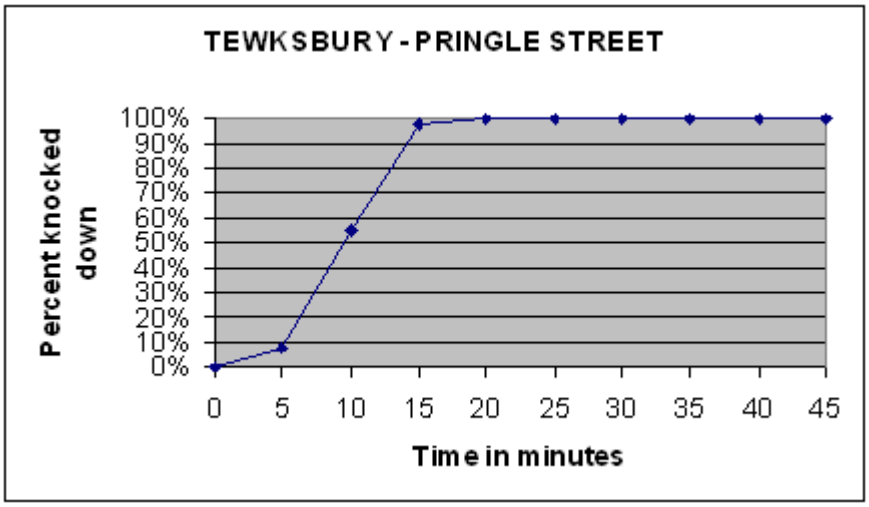
Time in minutes


TEWKSBURY - PRINGLE STREET
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
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5
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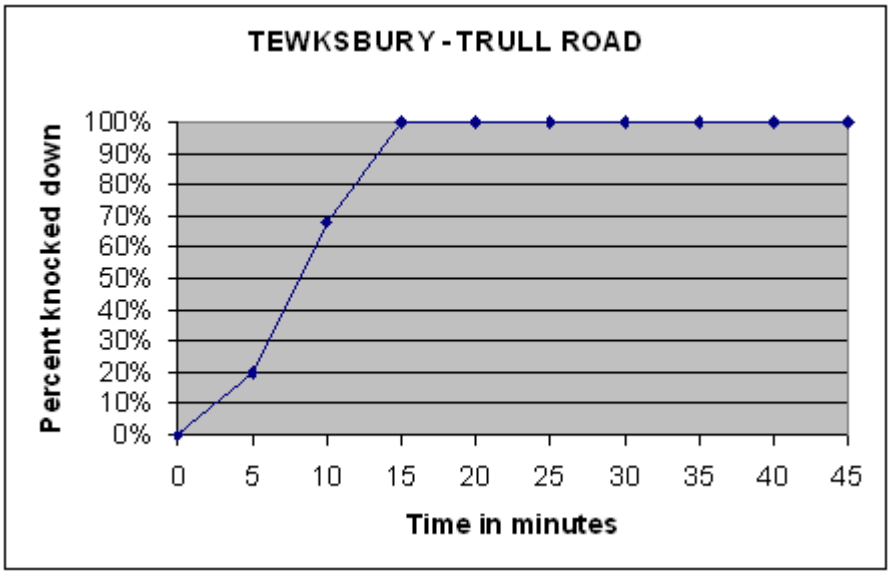
Time in minutes


TEWKSBURY - TRULL ROAD
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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5
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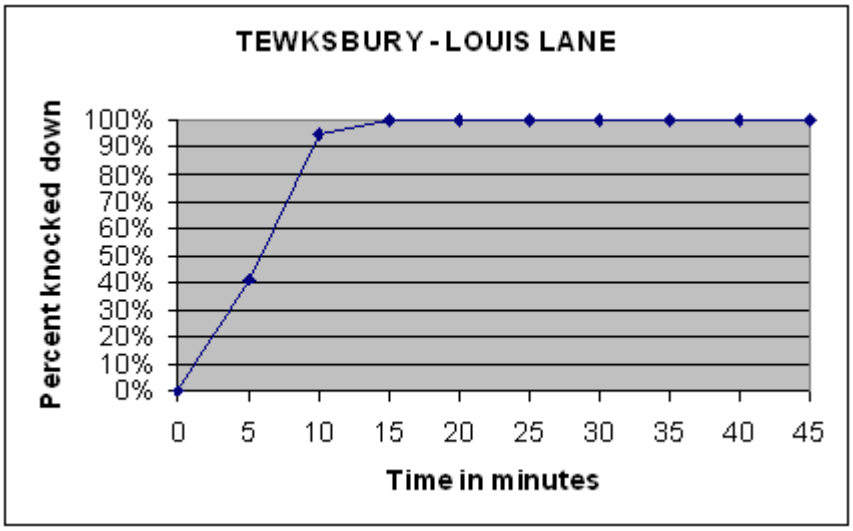
Time in minutes


TEWKSBURY - LOUIS LANE
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
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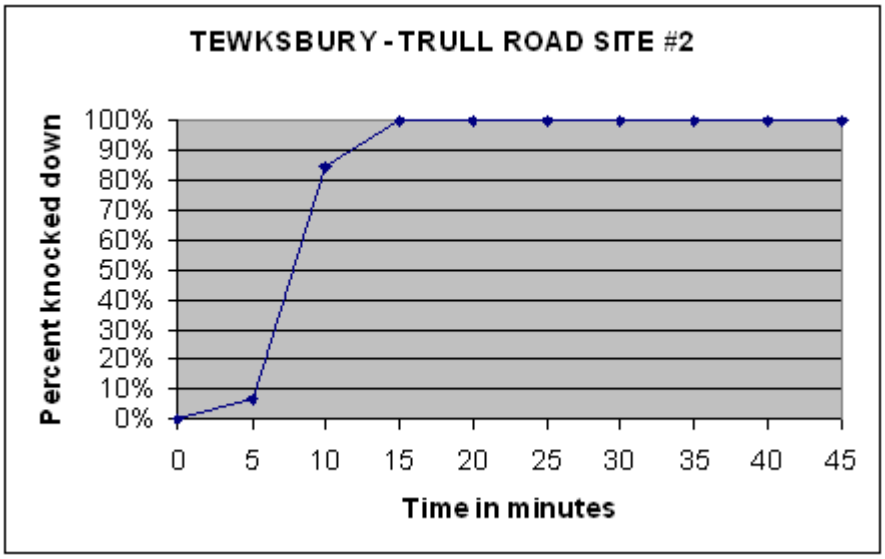
Time in minutes


TEWKSBURY - TRULL ROAD SITE #2
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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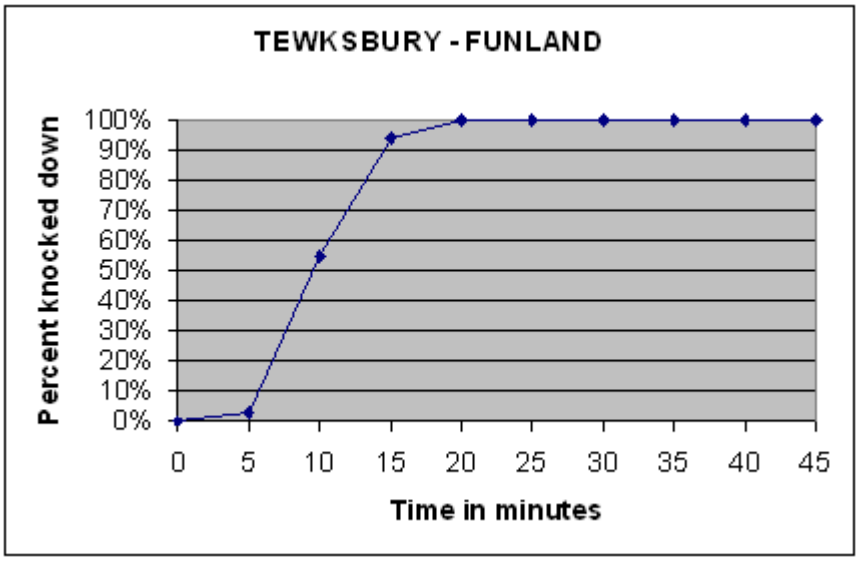
Time in minutes


TEWKSBURY - FUNLAND
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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5
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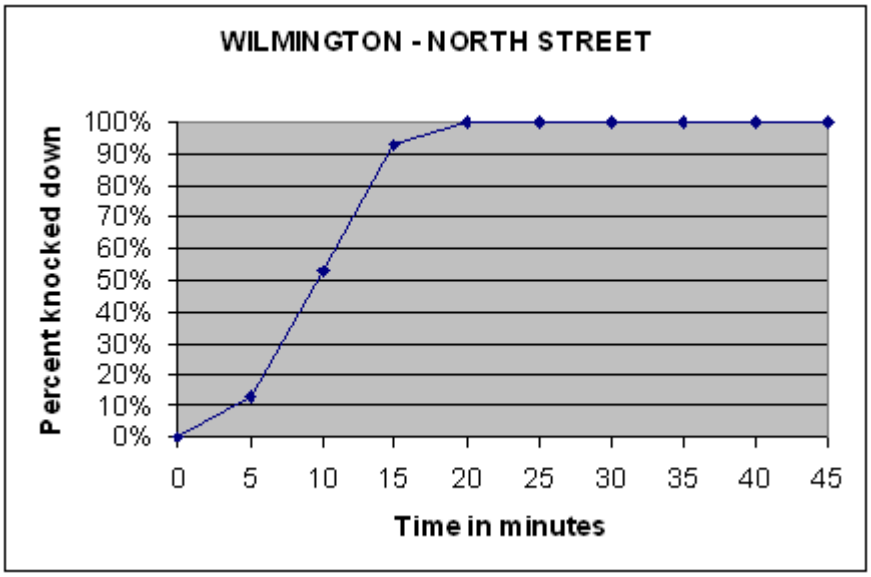
Time in minutes


WILMINGTON - NORTH STREET
Percent knocked down
100%
90%
80%
70%
60%
50%
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30%
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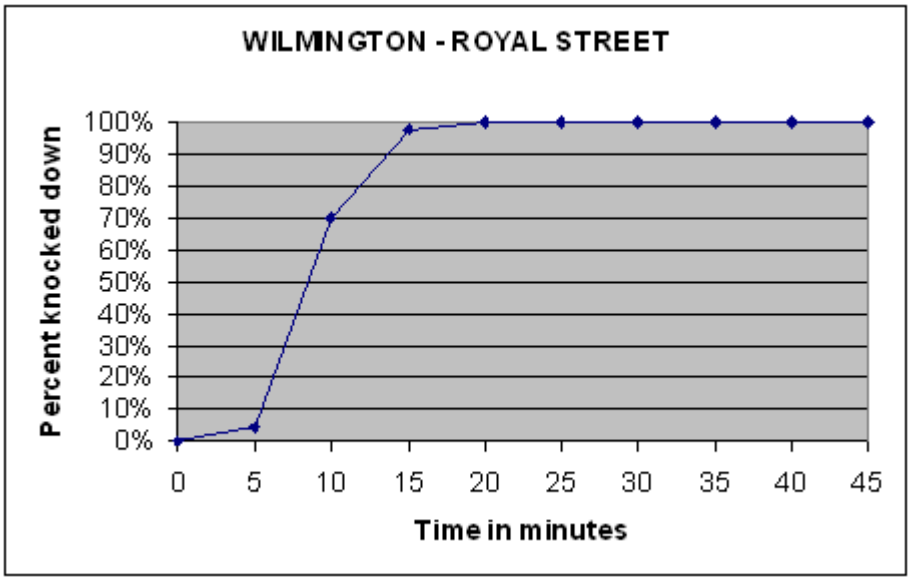
Time in minutes


WILMINGTON - ROYAL STREET
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
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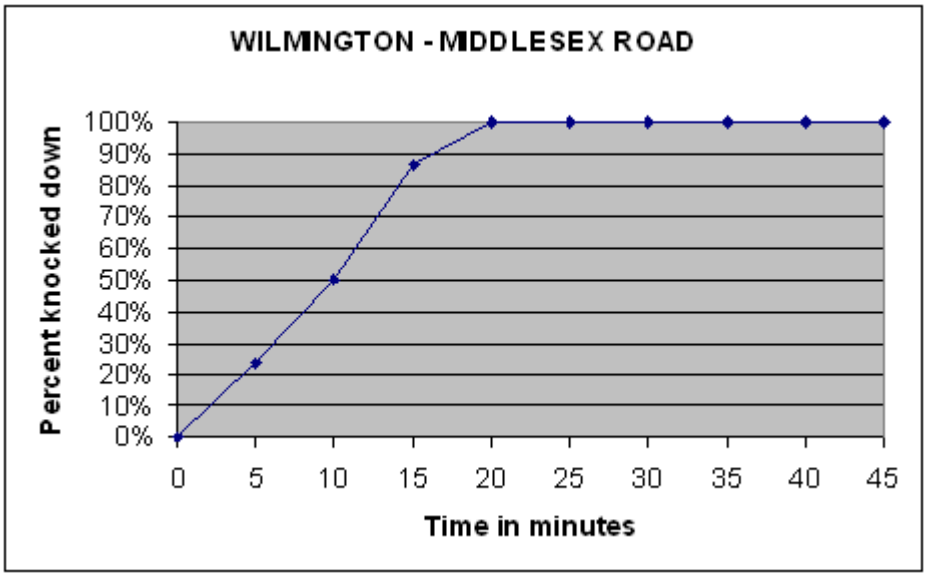
Time in minutes


WILMINGTON - MIDDLESEX ROAD
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
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0%
0
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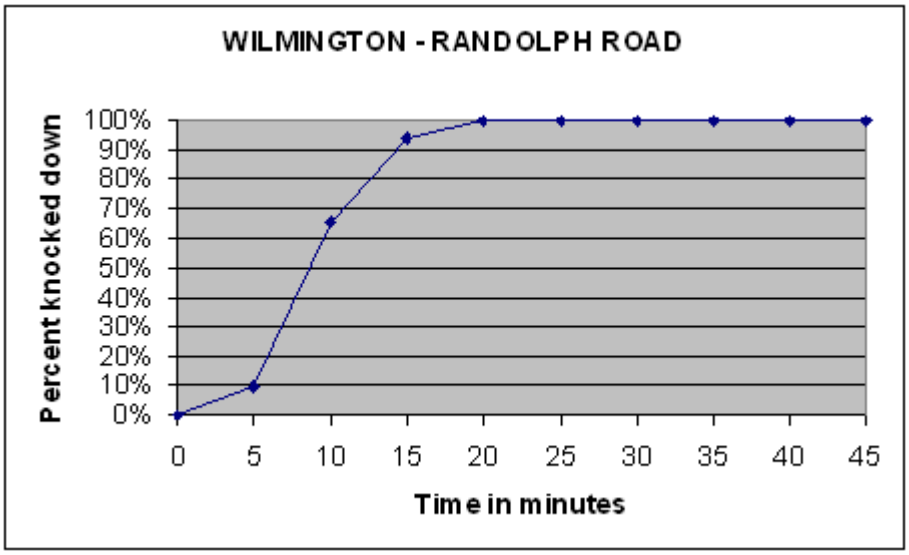
Time in minutes


WILMINGTON - RANDOLPH ROAD
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
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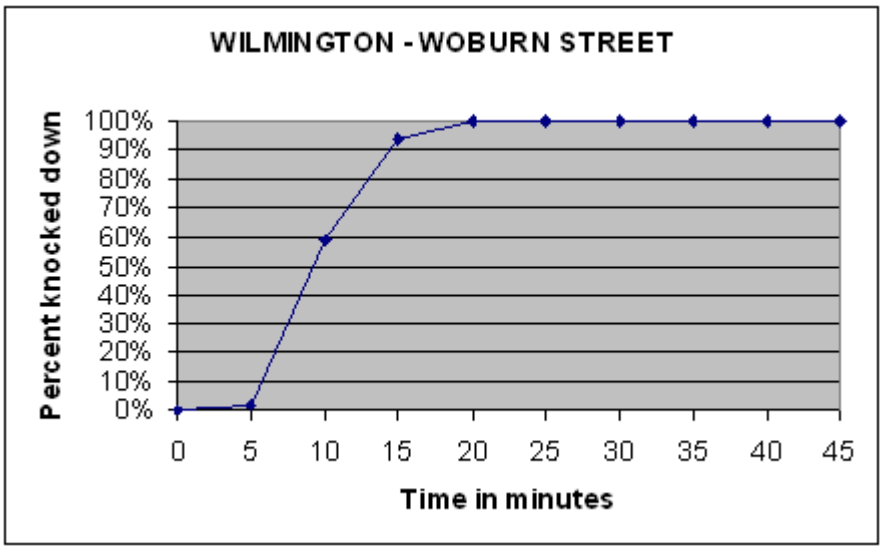
Time in minutes


WILMINGTON - WOBURN STREET
Percent knocked down
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
Time in minutes