

REPORT

Water Monitoring Results Associated With Aerial Pesticide Spraying for Eastern Equine Encephalitis Infected Mosquitoes in Summer 2012

**Massachusetts Department of Environmental Protection
Office of Research and Standards
Boston, MA**

September 2012

INTRODUCTION

In the summer of 2012, the prevalence of Eastern Equine Encephalitis (EEE) infected mosquitoes reached a sufficiently high level to warrant wide area aerial spraying to reduce the populations of mosquitoes. Plans followed the 2012 Massachusetts Arbovirus Surveillance and Response Plan (MassDPH, 2012) and were similar to those for spraying that took place in 1990, 2006, and 2010, although a different insecticide (the organophosphate Malathion) was used in 1990.

Two different spraying events took place during the summer. Surface water quality monitoring accompanied both spray events. In the first event of 2012, the sprayed area contained a number of surface water bodies which serve as sources of water for Public Drinking Water Supplies (PWS). Direct spraying onto these resources did not take place. Also sampled were several lakes, ponds and flowing waters not used for drinking water. The second, smaller spray event area did not include any water supply sources, but did include other surface waters.

Spraying in 2006, 2010 and 2012 used Anvil 10+10 which contain the insecticide sumithrin (d-phenothrin) and the synergist piperonyl butoxide (PBO). The purpose of this memorandum is to describe the water quality monitoring program in 2012 and present the results of the program.

MATERIALS AND METHODS

Spraying and sampling took place according to the Commonwealth's operational response plan (MassDAR, 2012). Details of application procedures and flight path information are available from the Massachusetts Department of Agricultural Resources.

The first spray event of 2012 included spraying on 4 evenings in order to cover the entire area, starting on the evening of July 20, 2012 and concluding on July 23, 2012. Areas were only sprayed once using these flight paths. The spray area in southeastern Massachusetts is shown in Figure 1. Flight crews were instructed to spray up to the edges of surface water bodies with no setbacks. Four of the locations where samples were taken were source water for PWS and the remaining seven locations were not. A second spray operation was necessary because of continuing high EEE infected mosquito counts in the towns of Easton, Norton, Taunton, Raynham, Bridgewater and West Bridgewater (Figure 2). This second spray application to this area took place the evening of August 13, 2012.

Massachusetts Aerial Spray Region 2012 (with exclusion areas)

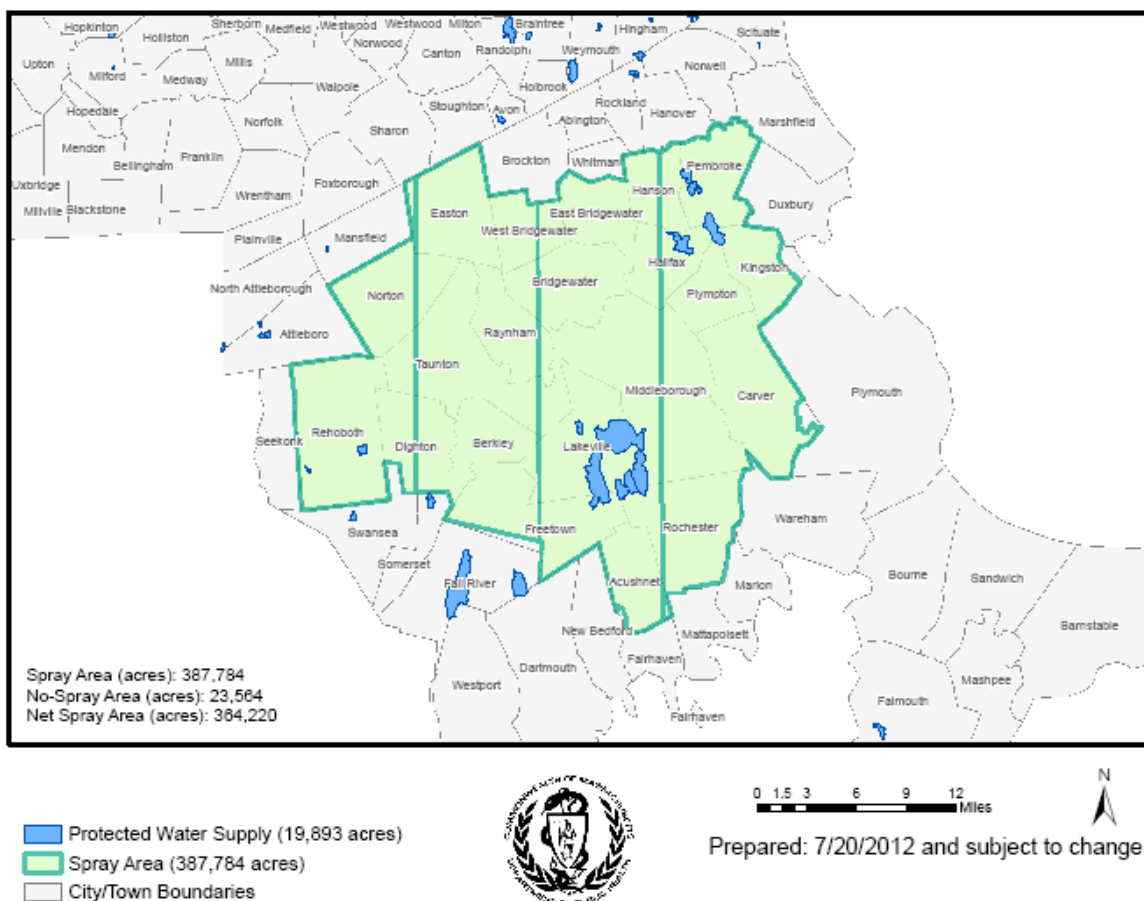


Figure 1. Aerial Spray Pattern for Spray Event 1. July 2012

For samples taken for waters serving PWSs, it should be noted that the PWS name (and sample location code) generally refer to the town that the water serves. In most cases, the water body serving as the source of that water and the associated water treatment plant are in a different town. This information has been noted in Table 1.

Pre-spray background samples were taken from each of the sampling locations on the day before the first spraying event took place. There was no background sampling at stations in advance of the second spray event because of the prior spray event. At all but the Abington/Rockland WTP in Pembroke, the raw water sample was collected from a tap coming into the plant from the waterbody. The Abington/Rockland raw water samples were taken directly from Great Sandy Bottom Lake. All finished water samples at each PWS were taken from a tap in each plant at the completion of treatment. Non-PWS surface water samples were collected directly from the waterbodies.

Water samples were collected at each location by approximately 8 am on the morning after spraying and then again daily for several days. A trip blank was included in the samples provided to the laboratory. Samples were placed on ice and conveyed within hours to the Massachusetts Pesticide Analysis Laboratory at the University of Massachusetts in Amherst where the analytes were extracted within 24 hours and analyzed for sumithrin (d-phenothrin) and PBO within 48 hours: both times within recommended limits for holding prior to extraction and analysis (48 hours and 30 days respectively) (Hladik, Smalling, & Kuivila, 2009). Details of the analytical procedure employed can be obtained from the laboratory. Their method detection limits were 0.02 ug/L and Limits of Quantitation were 0.1 ug/L for both compounds. Quality Control (QC) included determination of percent recoveries of spikes of the target analytes. No data were provided on analyses of replicate samples to indicate the level of precision of the analyses.

Massachusetts Aerial Spray Region August 2012

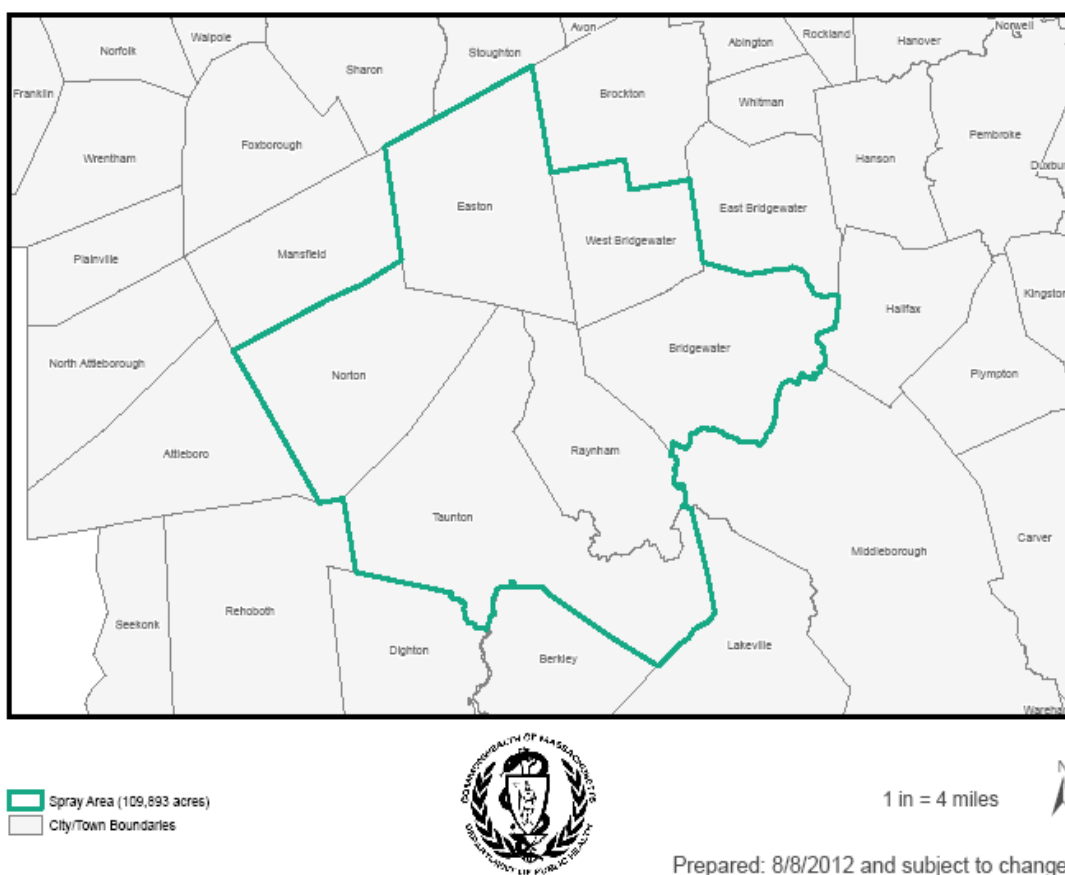


Figure 2. Aerial Spray Pattern for Spray Event 2. August 2012

RESULTS AND DISCUSSION

Water quality sampling results are shown in Table 1. Quality control results for both compounds were within acceptable limits for accuracy. No data were provided on analyses of replicate samples to indicate the level of precision of the analyses. Copies of lab data reports are appended (Appendix 1).

No Sumithrin was detected either before or after spraying in any water sample. Given that sumithrin degrades very quickly in the aquatic environment (US EPA 2008), any unmeasurable amounts of sumithrin present in the water after spraying would quickly degrade to insignificant levels.

PBO was not detected in any samples prior to spraying. PBO was detected in low sub ug/l (parts per billion) concentrations in some raw water samples, not used as PWSs, the morning after spraying in Spray Events 1&2, although it was not detected in any finished water samples during Event 1. It also occurred for the first time in the raw water of some of the PWSs sampled in Event 1 several days after application. Measured concentrations ranged from 0.02 to 0.42 ug/L (Tables 1 and 2). Post spray concentrations of PBO were consistent with those documented in the two prior EEE aerial spraying events in Massachusetts where Anvil 10+10 was employed (Table 2).

None of the reported PBO concentrations approached concentrations that would be of human health concern from either short or long-term exposures (Table 3). The maximum concentration of PBO measured after the two spray events was 150,000 fold lower than the US EPA's acute human health exposure limit for drinking water. It is important to emphasize here once again that PBO was never detected in finished drinking water samples, only in the raw water entering the treatment plants. The acute human health exposure limit is the most appropriate value for comparison with the monitoring data concentrations since PBO degrades rapidly in the aquatic environment (US EPA 2006). Chronic exposures would not therefore occur after these primarily single applications (or two applications in the case of the six towns sprayed a second time). The benchmark represents the U.S. EPA's most recent (2012) assessment of PBO's toxicity.

For the assessment of aquatic life, PBO concentrations were lower than the acute and chronic aquatic life benchmarks for PBO (Table 3), indicating little likelihood of any immediate or long-term toxicity from the episodic short-term PBO exposures after spraying. The acute exposure scenario is the most applicable to these spray events. Maximum PBO concentrations measured after spraying in both events were about 536 fold lower than the acute aquatic life benchmark for the most sensitive aquatic organism group (invertebrates).

Table 1. 2012 Sumithrin and PBO Water Monitoring Results for Two Aerial Spraying Events in Southeastern Massachusetts

Spray Event	Sample Location Code	Plant Location	Town Served by PWS	Sumithrin, ug/L					PBO, ug/L				
				Pre-Spray	Post-Spray				Pre-Spray	Post-Spray			
					7/20	7/21	7/22	7/23		7/24	7/20	7/21	7/22
PWS Surface Water Supply Samples													
	Ab/Rock-002 Raw	Great Sandy Bottom WTP, Pembroke	Abington/Rockland	ND	ND	ND	ND	ND	ND	ND	ND	0.07	0.028
	Ab/Rock 001 Finished	Great Sandy Bottom WTP, Pembroke	Abington/Rockland	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	7-20-12 Quittacas raw	Quittacas* WTP	New Bedford	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.04
	7-20-12 Quittacas finished	Quittacas* WTP	New Bedford	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Brockton Silver Lake raw	Silver Lake WTP, Pembroke/Kingston	Brockton	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.03
	Brockton Silver Lake finished	Silver Lake WTP, Pembroke/Kingston	Brockton	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	021 Elders Pond raw	Elders Pond WTP, Lakeville	Taunton	ND	ND	ND	ND	ND	ND	ND	ND	0.026	0.02
	022 24" finished	Elders Pond WTP, Lakeville	Taunton	ND	ND	ND	ND		ND	ND	ND	ND	ND

* This WTP draws water from 5 ponds in the area: Assawampsett Pond, Great Quittacas Pond, Long Pong, Pocksha Pond and Little Quittacas Pond. Sample was from intake tap.

Table 1 cont. 2012 Sumithrin and PBO Water Monitoring Results for Two Aerial Spraying Events in Southeastern Massachusetts

Spray Event	Sample Location Code	Sample Location	Town	Sumithrin, ug/L					PBO, ug/L			
				Pre-Spray		Post-Spray			Pre-Spray		Post-Spray	
				7/20	7/21	7/22	7/23	7/24	7/20	7/21	7/22	7/23
Non-PWS Surface Water Samples from Ponds, Impoundments or Rivers												
1	Jones River	Jones River Impoundment	Kingston	ND	ND	ND	ND	ND	ND	0.27		
	Ponkapog (sic) Pond	Ponkapoag Pond	Randolph / Canton	ND	ND	ND	ND	ND	ND	ND		
	Lower Leach Pond		Easton	ND	ND	ND	ND	0.04	0.07	0.03		
	Lake Sabbatia	Lake Sabbatia	Taunton	ND	ND	ND	ND	0.19	0.07	0.11		
	Snipatuit Pond	Snipatuit Pond	Middleborough	ND	ND	ND	ND	ND	ND	0.42		
	Sampson Pond	Sampson Pond	Carver	ND	ND	ND	ND	ND	ND	0.05		
	Nemasket	Nemasket River	Middleborough	ND	ND	ND	ND	ND	ND	ND		
	SERO		trip blank							ND		
2				Pre Spray	Post Spray			Pre Spray	Post Spray			
	Leach Pond		Easton	-	ND			-	ND			
	Norton Reservoir		Norton	-	ND			-	0.12			
	Lake Nip	Lake Nippenicket	Bridgewater	-	ND			-	0.37			
	Lake Rico		Taunton	-	ND				0.19			

Table 2. Summary of PBO Concentrations (ug/L) Observed in Massachusetts Surface Waters after Aerial Spraying Events for EEE

Year	Frequency of detection	max	min
2006	7*/77 = 0.06	0.14	0.13
2010	14**/26 = 0.54	0.36	0.11
2012	18/57 = 0.31	0.42	0.02

* includes 3 < LOQ of 0.08 ug/L; ** includes 7 < LOQ of 0.1 ug/L

Table 3. Summer 2012 Updated Drinking Water and Aquatic Life Benchmark Concentrations for Sumithrin and PBO

Receptors	Compound	Exposure Duration	OPP* Aquatic Life Benchmark, ug/L	US EPA Drinking Water Benchmark** ug/L	Source	
Humans	Sumithrin	chronic	-	49	US EPA 2012a	
		acute	-	990 (females 13-49)	US EPA 2012a	
	PBO	chronic	-	1,085	US EPA 2012a	
		acute	-	63,000 (children)	US EPA 2012a	
Aquatic Animals						
Fish	Sumithrin	acute	7.9	-	US EPA 2012b	
		chronic	1.1	-	US EPA 2012b	
		Inverts	acute	2.2	-	US EPA 2012b
			chronic	0.47	-	US EPA 2012b
	PBO	Fish	acute	950	-	US EPA 2012b
		Fish	chronic	40	-	US EPA 2012b
		Inverts	acute	225	-	US EPA 2012b
		Inverts	chronic	30	-	US EPA 2012b

* OPP = US EPA Office of Pesticide Programs

**ACUTE: The US EPA Formula for deriving the Acute Drinking Water Benchmark = $[RfD_{acute} \text{ (mg/kg bw/day)} \times BW \text{ (kg)} \times 1000 \text{ (}\mu\text{g/mg)}] / [\text{Drinking Water Intake (L/day)}]$ where BW=10 kg for children and 66 kg for females 13-49 years and Drinking Water Intake = 1L/day for children and 2L/day for females 13-49 years. Concentrations for both children and the female group are calculated and the lower of the two is shown as the benchmark with a notation of which group it was based upon. No relative source contribution factor is applied to the acute values.

CHRONIC: The US EPA Formula for deriving the Chronic Drinking Water Benchmark = $[RfD_{chronic} \text{ (mg/kg bw/day)} \times BW \text{ (kg)} \times 1000 \text{ (}\mu\text{g/mg)} \times 0.2 \text{ RSC}] / [\text{Drinking Water Intake (L/day)}]$ where BW=70 kg for general population and 66 kg for females 13-49 years and Drinking Water Intake = 2L/day for general population as well as for females 13-49 years and RSC = Relative Source Contribution assumed as 20%. The general population based Benchmark is shown.

CONCLUSION

Wide area aerial spraying with Anvil 10+10 (sumithrin and PBO) did not result in any significant introduction of sumithrin or PBO into surface waters in the spray areas. No sumithrin was detected approximately 12 hours after spraying, nor for several days thereafter. PBO was detected in some locations at low sub ug/L (ppb) concentrations which were well below acute

drinking water or aquatic life exposure criteria. These results are consistent with those of previous EEE spraying operations in Massachusetts.

REFERENCES

Hladik, M. L., Smalling, K. L., & Kuivila, K. M. (2009). *Methods of analysis-Determination of pyrethroid insecticides in water and sediment using gas chromatography/mass spectrometry: U.S. Geological Survey Techniques and Methods 5-C2*. Reston, VA: U.S. Geological Survey.

MassDPH. 2012. Massachusetts Arbovirus Surveillance and Response Plan. Massachusetts Department of Public Health. Boston, MA. Available at:
<http://www.mass.gov/eohhs/docs/dph/cdc/arbovirus/arbovirus-surveillance-plan.pdf>

MassDAR. 2012. Operational Response Plan To Reduce The Risk Of Mosquito-Borne Disease In Massachusetts. July 16, 2012. Massachusetts Department of Agricultural Resources. State Reclamation and Mosquito Control Board. Boston MA. Available at:
<http://www.mass.gov/agr/mosquito/docs/2012-ARBOVIRUS-SRMCB-OPERATIONAL-PLAN.pdf>.

US EPA. 2006. Registration Eligibility Decision for Piperonyl Butoxide (PBO). List B, Case No. 2525. Report EPA 738-R-06-005. June 2006.

US EPA. 2008. Reregistration Eligibility Decision for d-Phenothrin. List A. Case No. 0426. Report from Office of Prevention, Pesticides and Toxic Substances. September 2008. Washington, DC.

US EPA. 2012a. Human Health Benchmarks for Pesticides. Available at:
<http://iaspub.epa.gov/apex/pesticides/f?p=HHBP:home>. Accessed 08 08 2012.

US EPA. 2012b. Office of Pesticide Programs' Aquatic Life Benchmarks. Available at:
http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm. Accessed 08 08 2012

ACKNOWLEDGEMENTS

The work described in this report was performed by a number of individuals whose contributions are gratefully acknowledged: Gary Gonyea (MassDEP/Bureau of Resource Protection), MassDEP/Southeast Regional Office staff including Leslie O'Shea, Greg DeCesare, Michael Quink and Jonathan Hobil, MassDepartment of Agricultural Resources staff including Taryn LaScola, staff members of the Public Water Supplies sampled, and Jeff Doherty (The University of Massachusetts Amherst's Pesticide Analysis Laboratory).

APPENDIX A

University of Massachusetts, Amherst
Pesticide Analysis Laboratory Data Reports

Massachusetts Pesticide Analysis Laboratory

Morrill 1 N427A
637 North Pleasant Street
University of Massachusetts
Amherst, MA 01003-0230
Phone: 413-545-4369

Massachusetts Department of Environmental Protection

Report of Analysis

Sumithrin/PBO Water Analysis

Reviewed and Approved by:

Jeffery J. Doherty
Laboratory Manager

Massachusetts Pesticide Analysis Laboratory

Report Date: 7/23/12
Project: DEP
Container: 1 L amber glass
Preservation: 4°C storage
Matrix: water

Sampled: 7/20/12
Received: 7/20/12
Extracted: 7/21/12
Analyzed: 7/22/12
Analyst: SAM/JJD

RESULTS Background samples		
<u>Sample</u>	<u>PBO</u>	<u>Sumithrin</u>
Ab/Rock 001 Finished	ND	ND
Ab/Rock-002 Raw	ND	ND
7-20-12 Quittacas raw	ND	ND
7-20-12 Quittacas finished	ND	ND
Brockton Silver Lake raw	ND	ND
Brockton Silver Lake finished	ND	ND
021 Elders Pond raw	ND	ND
022 24" finished	ND	ND

Notes:

ND = not detected. The limit of detection is 0.02 µg/L, and the limit of quantitation (LOQ) is 0.1 µg/L.

QC Results		
<u>Parameter</u>	<u>Recovery</u>	<u>QC Limits</u>
PBO (1 µg/L)	79%	60% -120 %
Sumithrin (1 µg/L)	68%	60% -120 %

Massachusetts Pesticide Analysis Laboratory

Report Date: 7/23/12
Project: DEP
Container: 1 L amber glass
Preservation: 4°C storage
Matrix: water

Sampled: 7/21/12
Received: 7/21/12
Extracted: 7/21-22/12
Analyzed: 7/23/12
Analyst: SAM/JJD

RESULTS		
Post spray sample collection of 7/21/12		
<u>Sample</u>	<u>PBO</u>	<u>Sumithrin</u>
Ab/Rock 001Finished	ND	ND
Ab/Rock-002 Raw	ND	ND
7-20-12 Quittacas raw	ND	ND
7-20-12 Quittacas finished	ND	ND
Brockton Silver Lake raw	ND	ND
Brockton Silver Lake finished	ND	ND
021 Elders Pond raw	ND	ND
022 24" finished	ND	ND
Jones river	ND	ND
Ponkapog Pond	ND	ND
Lower Leach Pond	0.04ppb	ND
Lake Sabbatia	0.19ppb	ND
Snipatuit Pond	ND	ND
Sampson Pond	ND	ND
Nemasket	ND	ND

Notes:

ND = not detected. The limit of detection is 0.02 µg/L, and the limit of quantitation (LOQ) is 0.1 µg/L.

QC Results		
<u>Parameter</u>	<u>Recovery</u>	<u>QC Limits</u>
PBO (1 µg/L)	107%	60% -120 %
Sumithrin (1 µg/L)	87%	60% -120 %

Massachusetts Pesticide Analysis Laboratory

Report Date: 7/24/12
Project: DEP
Container: 1 L amber glass
Preservation: 4°C storage
Matrix: water

Sampled: 7/22/12
Received: 7/22/12
Extracted: 7/22-23/12
Analyzed: 7/23-24/12
Analyst: SAM/JJD

RESULTS		
Post spray sample collection of 7/22/12		
<u>Sample</u>	<u>PBO</u>	<u>Sumithrin</u>
Ab/Rock 001 Finished	ND	ND
Ab/Rock-002 Raw	ND	ND
7-20-12 Quittacas raw	ND	ND
7-20-12 Quittacas finished	ND	ND
Brockton Silver Lake raw	ND	ND
Brockton Silver Lake finished	ND	ND
021 Elders Pond raw	ND	ND
022 24" finished	ND	ND
Jones river	ND	ND
Ponkapog Pond	ND	ND
Lower Leach Pond	0.07ppb	ND
Lake Sabbatia	0.07ppb	ND
Snipatuit Pond	ND	ND
Sampson Pond	ND	ND
Nemasket	ND	ND
SERO (trip blank)	ND	ND

Notes:

ND = not detected. The limit of detection is 0.02 µg/L, and the limit of quantitation (LOQ) is 0.1 µg/L.

QC Results		
<u>Parameter</u>	<u>Recovery</u>	<u>QC Limits</u>
PBO (1 µg/L)	86%	60% -120 %
Sumithrin (1 µg/L)	87.1%	60% -120 %

Massachusetts Pesticide Analysis Laboratory

Report Date: 7/25/12
Project: DEP
Container: 1 L amber glass
Preservation: 4°C storage
Matrix: water

Sampled: 7/23/12
Received: 7/23/12
Extracted: 7/23-24/12
Analyzed: 7/24/12
Analyst: SAM/JJD

RESULTS		
Post spray sample collection of 7/23/12		
<u>Sample</u>	<u>PBO</u>	<u>Sumithrin</u>
Ab/Rock 001Finished	ND	ND
Ab/Rock-002 Raw	0.07ppb	ND
7-20-12 Quittacas raw	ND	ND
7-20-12 Quittacas finished	ND	ND
Brockton Silver Lake raw	ND	ND
Brockton Silver Lake finished	ND	ND
021 Elders Pond raw	0.026ppb	ND
022 24" finished	ND	ND
Jones river	0.27ppb	ND
Ponkapog Pond	ND	ND
Lower Leach Pond	0.03ppb	ND
Lake Sabbatia	0.11ppb	ND
Snipatuit Pond	0.42ppb	ND
Sampson Pond	0.05ppb	ND
Nemasket	ND	ND

Notes:

ND = not detected. The limit of detection is 0.02 µg/L, and the limit of quantitation (LOQ) is 0.1 µg/L.

QC Results		
<u>Parameter</u>	<u>Recovery</u>	<u>QC Limits</u>
PBO (1 µg/L)	119%	60% -120 %
Sumithrin (1 µg/L)	68.7%	60% -120 %

Massachusetts Pesticide Analysis Laboratory

Report Date: 7/26/12
Project: DEP
Container: 1 L amber glass
Preservation: 4°C storage
Matrix: water

Sampled: 7/24/12
Received: 7/24/12
Extracted: 7/24/12
Analyzed: 7/25/12
Analyst: SAM/JJD

RESULTS		
Post spray samples 7/24/12		
<u>Sample</u>	<u>PBO</u>	<u>Sumithrin</u>
Ab/Rock 001Finished	ND	ND
Ab/Rock-002 Raw	0.028ppb	ND
7-20-12 Quittacas raw	0.04ppb	ND
7-20-12 Quittacas finished	ND	ND
Brockton Silver Lake raw	0.03ppb	ND
Brockton Silver Lake finished	ND	ND
021 Elders Pond raw	0.02ppb	ND
022 24" finished	ND	ND

Notes:

ND = not detected. The limit of detection is 0.02 µg/L, and the limit of quantitation (LOQ) is 0.1 µg/L.

QC Results		
<u>Parameter</u>	<u>Recovery</u>	<u>QC Limits</u>
PBO (1 µg/L)	117%	60% -120 %
Sumithrin (1 µg/L)	67.7%	60% -120 %

Massachusetts Pesticide Analysis Laboratory

Report Date: 8/16/12
Project: DEP
Container: 1 L amber glass
Preservation: 4°C storage
Matrix: water

Sampled: 8/14/12
Received: 8/14/12
Extracted: 8/14/12
Analyzed: 8/15/12
Analyst: SAM/JJD

RESULTS		
Post spray samples 8/14/12		
<u>Sample</u>	<u>PBO</u>	<u>Sumithrin</u>
Leach Pond, Easton	ND	ND
Norton Res., Norton	0.12ppb	ND
Lake Nip, Bridgewater	0.37ppb	ND
Lake Rico, Taunton	0.19ppb	ND

Notes:

ND = not detected. The limit of detection is 0.02 µg/L (ppb), and the limit of quantitation (LOQ) is 0.1 µg/L (ppb).

QC Results		
<u>Parameter</u>	<u>Recovery</u>	<u>QC Limits</u>
PBO (1 µg/L)	109%	60% -120 %
Sumithrin (1 µg/L)	94%	60% -120 %

