Effects of Clothianidin on *Bombus impatiens* (Hymenoptera: Apidae) Colony Health and Foraging Ability

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ABSTRACT We conducted laboratory experiments to investigate the lethal and sublethal effects of clothianidin on bumble bee, *Bombus impatiens* Cresson, colony health and foraging ability. Bumble bee colonies were exposed to 6 ppb clothianidin, representing the highest residue levels found in field studies on pollen, and a higher dose of 36 ppb clothianidin in pollen. Clothianidin did not effect pollen consumption, newly emerged worker weights, amount of brood or the number of workers, males, and queens at either dose. The foraging ability of worker bees tested on an artificial array of complex flowers also did not differ among treatments. These results suggest that clothianidin residues found in seed-treated canola and possibly other crops will not adversely affect the health of bumble bee colonies or the foraging ability of workers.

KEY WORDS *Bombus impatiens*, bumble bees, clothianidin, chloronicotinyl insecticide, seed dressing

SYSTEMIC INSECTICIDES SUCH AS chloronicotinyl compounds are distributed throughout plant tissues, providing cultivated crops with protection from both root and foliar pests (Mullins 1993, Tasei et al. 2000). Clothianidin, the newest member of the chloronicotinyl insecticide family, has recently been registered in Japan for foliar spray and seed treatment applications under the trade names Fullswing and Dantotsu, and registration is pending in North America and Europe under the trade names Poncho and Clutch (Jeschke et al. 2003). Clothianidin has a high activity against a broad range of insects, including sucking insects, chewing insects, and some lepidopterans (Jeschke et al. 2003).

Wild pollinators may be experiencing declines worldwide with unknown consequences for the yield of food crops. One factor contributing to pollinator declines is pesticides (Allen-Wardell et al. 1998), and clothianidin-treated crops could be hazardous to managed and wild bees that feed on pollen and nectar-containing residues. To date, only one study that includes two field trials has examined the effects of clothianidin seed-treated canola on honey bees, *Apis mellifera* L., and found no adverse effect on colony health at residue levels ranging from 0.9 to 3.7 ppb (Scott-Dupree, personal communication). However, no studies have investigated the lethal or sublethal effects of clothianidin residues on wild or other managed pollinators in the field or laboratory.

Exposure to clothianidin at sublethal levels may adversely affect the foraging ability of pollinators, because it is neurotoxic and therefore could cause coordination problems (Kiriyama and Nishimura 2002). The sublethal effects of a similar neonicotinoid, imidacloprid, have been tested on bumble bees and honey bees (Schmuck et al. 1999, 2001; Morandin and Winston 2003). *Bombus impatiens* Cresson workers exposed to imidacloprid in previous tests showed no effect at field residue levels, but at a dose 5 times higher than the highest residue levels, bees showed reduced foraging ability and trembling (Morandin and Winston 2003). In addition, Schmuck et al. (1999) found that imidacloprid reduced the ability of honey bees to recruit other foragers to nectar and pollen sources at doses >20 ppb. Although both clothianidin and imidacloprid are members of the chloronicotinyl family, clothianidin is chemically different, and its effects on bees are unknown.

The objective of our study was to investigate the lethal and sublethal effects of clothianidin on *B. impatiens* colony health and foraging ability. First, we examined the effects of clothianidin on brood development and colony size at levels similar to and higher than those found in the nectar and pollen of seed-treated crops. Second, we assessed the ability of foraging bees exposed to these levels to access artificial complex flowers. We hypothesized that the high clothianidin dose would adversely affect colony health and foraging ability of workers.

Materials and Methods

On 16 May 2002, 24 *B. impatiens* colonies were received from Biobest Canada Ltd. (Leamington, ON, Canada). Each colony consisted of one queen and between 7 and 19 workers (first and second brood stage). Colonies were housed in cardboard boxes containing 20 by 28 by 18-cm plastic nesting boxes with several ventilation openings. Bottles of Biogluc (provided in colony boxes by Biobest Canada Ltd.) containing sugar water and preservative, located underneath the nest boxes, were fed to the bees ad libitum.

Technical grade clothianidin, C(*E*)-*N*-((2-chloro-5-thiazolyl)methyl)-*N*′ –methyl-*N*″-nitroguanidine, with a purity of 99.75%, was obtained from Bayer AG (Leverkusen, Germany). The 24 colonies were randomly assigned to the following three treatments: 1) control, 2) low clothianidin, and 3) high clothianidin. The control colonies were fed a mixture of pollen and sugar water, whereas the low and high clothianidin treatments had clothianidin concentrations of 6 and 36 ppb in the pollen/sugar water mixtures, respectively. The low-dose clothianidin represented a realistic level of active ingredient found in nectar and pollen after seed treatment of canola (Scott-Dupree, personal communication). The high-dose clothianidin was similar in concentration to the chloronicotinyl insecticide imidacloprid tested in previous colony health and foraging ability studies by Morandin and Winston (2003).

Pollen traps were used to collect pollen from honey bee colonies at Simon Fraser University (Burnaby, BC, Canada) during May and June 2002. Chalk brood and dead insects were cleaned from the collected pollen. After cleaning, the pollen was ground up with an electric food processor and frozen for future use. A clothianidin solution was prepared by performing a 10,000-fold dilution of clothianidin in distilled water. The solution was mixed for 8 h in the dark, and stored at 4°C in a refrigerator. Before pollen preparation, the clothianidin solution was stirred at room temperature for 2 h to ensure all clothianidin was dissolved. The 6 and 36 ppb clothianidin doses were added to 30% sucrose solutions made with distilled water and stirred for 5 min. The sucrose solutions were added to the mashed pollen in a 2:1 pollen to solution ratio and stirred for an additional 5 min. Pollen mixtures were stored frozen and samples were sent to Bayer AG (Monheim, Germany) for verification of treatment doses. The analytical results of the pollen samples confirmed that treatment doses were 5.8 ± 0.2 and 35 ± 0.7 ppb. Colonies were fed pollen mixtures biweekly ad libitum. During each feeding, old pollen was weighed and removed from the dishes and replaced with a preweighed amount of new pollen.

Colony Health. During the first week of the experiment, 10 workers, or all workers if there were fewer than 10, were placed in vials and weighed on an Ohaus Explorer electronic balance (Ohaus Company, Florham Park, NJ) to 0.01 g. In subsequent weeks, a maximum of three newly emerged workers, identified by their white coloration, were removed from each colony weekly, placed in vials, and weighed. It was not always possible to obtain three weight measurements, because the number of bees emerging each week was variable. The number of workers, brood (egg masses, larval masses, larval cells, and pupae), queens, and males were recorded weekly. In addition, weekly counts of the number of dead workers, queens, and males were conducted.

Foraging Assay. Twenty-one days after experiment initiation, all workers were marked with white Liquid Paper. These workers were excluded from foraging trials to ensure that all foraging tests were performed on workers that had been exposed to clothianidin throughout their entire development and were of similar age.

Foraging experiments began 2 July 2002, 48 d after the start of exposure. Colonies were connected to a 1.2 by 1.2 by 1-m mesh flight cages by a 3 by 3 by 32-cm mesh tunnel with two entrance gates. An artificial foraging array was set up inside each flight cage (Morandin and Winston 2003). The array was comprised of 30 artificial flowers made from 1.5-ml clear microtubes (Sarstedt, Newton, NC) set in a 60 by 60 by 5-cm styrofoam foundation covered with green cardboard. Artificial flowers were set 10 cm apart in rows. The rows were placed 5 cm apart and staggered, resulting in a distance of ≈7 cm between flowers.

First, workers were trained to forage on an array of simple artificial flowers made from microtubes with lids completely removed. The training process began by removing the nectar supply and connecting the colony to a flight cage. An array of 30 simple flowers filled with 30% sucrose solution was placed in the flight cage. Ten to 20 workers making repeated foraging trips were marked on their abdomen and thorax with distinct Liquid Paper color combinations. Once the foragers were marked, the flight cage entrance gates were closed and all bees were returned to the hive. The array of simple flowers was removed and replaced with an array of 17 complex flowers made from microtubes with lids folded over to create openings of ≈4 mm (Gegear and Laverty 1998). A 100-μl syringe and PB600 2-μl dispenser (Hamilton Company, Reno, NV) was used to add 2 μl of 30% sucrose solution to each of the complex flowers. The entrance gates were opened to allow one marked forager into the flight cage. The forager was videotaped for a minimum of 35 successful flower visits. A flower visit was considered to be successful when the bee's entire body was inside the flower, and the 2 μl of sucrose solution was consumed. Flowers were refilled with 2 μl of the 30% sucrose solution after each successful flower visit. After the bee had completed a minimum of 35 successful flower visits, it was returned to the hive. Each forager was only tested once on the complex array of flowers.

Foraging tests were conducted from 10 July 2002 to 6 August 2002. Foragers from two colonies were trained concurrently, because two flight cages were used throughout the experiment. Only three colonies from each treatment were used in the foraging trials because the life span of colonies was too short to continue testing additional colonies. Foraging trials were divided into three blocks, defined as the completion of foraging trials by bees from one colony of each of three treatments. The treatment order for each block was as follows: 36 ppb clothianidin, 6 ppb clothianidin, and control. New colonies were used in each block and the treatment order remained the same. Foraging tests were performed on four to six bees from each colony. A total of 18, 15, and 11 bees were tested from the control, 6 ppb clothianidin, and 36 ppb clothianidin treatments, respectively. Each colony was trained and tested over a period of 5–8 d.

Access times for the 35 successful flower visits were recorded from foraging videos for each bee. Access time was defined as the time a forager spent in contact with flowers before making a successful flower visit. A stopwatch was used to measure access time to one hundredth of a second.

Data Analysis. Each colony represented one replicate for all data analyses. To compare weekly pollen consumption per bee, we performed a repeated measures analysis of variance (ANOVA) (JMP 2001) with treatment as the main effect and time as the repeated factor. Univariate ANOVA (PROC MIXED, SAS Institute 1999) with treatment as the main effect was used to analyze the weekly average weights of newly emerged bees for each colony. PROC MIXED procedures were used for this analysis because they are robust to missing values. Because the design was unbalanced, i.e., there was an unequal number of bees weighed per treatment, the test statistics did not follow an exact F distribution, so approximate *P* values were computed using an F approximation with fractional degrees of freedom (Satterthwaite approximation, SAS Institute 1999). Repeated measures ANOVA (JMP 2001) with treatment as the main effect and time as the repeated factor was used to test for differences in the total amount of brood and number of workers over time among treatments. Univariate ANOVA (JMP 2001) with treatment as the main effect was used to compare the total number of queens and males produced among treatments. All colony health variables were log transformed to improve homoscedasticity; reported means and SE are from the nontransformed data.

A repeated measures ANOVA (JMP 2001) with treatment as the main effect and flower number as the repeated factor was used to compare the mean access time among treatments for flower visits 1–35. Univariate ANOVA (JMP 2001) with treatment as a main effect and block as a random factor was used to compare learning rates and mean access time among treatments for both the first 10 flowers and flowers 20–35, respectively. The learning rate was defined as the difference in mean access time between flower visits 1–10 and 20–35. Block was included in the model to control for the effects of colony age.

Results

Colony Health. The mean weekly pollen consumption per bee (±SE) was 0.26 ± 0.02, 0.27 ± 0.02, and 0.23 ± 0.01 g in the control, 6 ppb clothianidin, and 36 ppb clothianidin treatments, respectively, and was not different among treatments ($F = 0.66$; df = 2, 21; $P =$ 0.53). There were no interactions between treatment and time for the main effects newly emerged bee weights ($F = 1.49$; df = 12, 117; $P = 0.14$), number of workers ($F = 0.96$; df = 24, 20; $P = 0.54$), and brood ($F = 0.85$; df = 24, 20; $P = 0.65$). The mean weights of newly emerged workers were not different among treatments ($F = 0.41$; df = 2, 21.8; $P = 0.67$; Fig. 1), and mean number of workers and brood also did not differ ($F = 2.83$; df = 2, 21; $P = 0.08$ and $F = 0.59$; df = 2, 21; $P = 0.56$, respectively; Fig. 2). In addition, there was no difference in the total number of males or queens produced among treatments ($F = 1.25$; df = 2, 21; $P =$ 0.31 and $F = 0.38$; df = 2, 21; $P = 0.69$, respectively; Fig. 3).

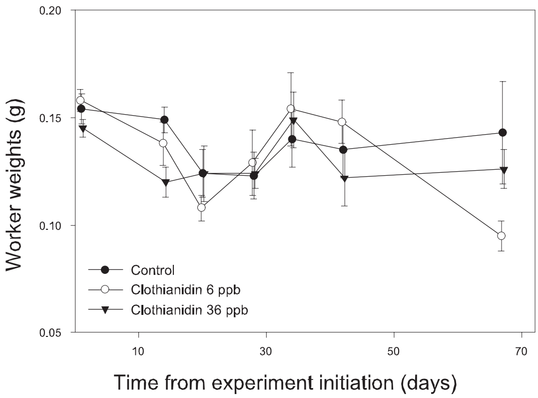

Fig. 1. Mean (±SE) worker weights for eight *B. impatiens* colonies from each of the three treatments; control, 6 ppb clothianidin, and 36 ppb clothianidin.

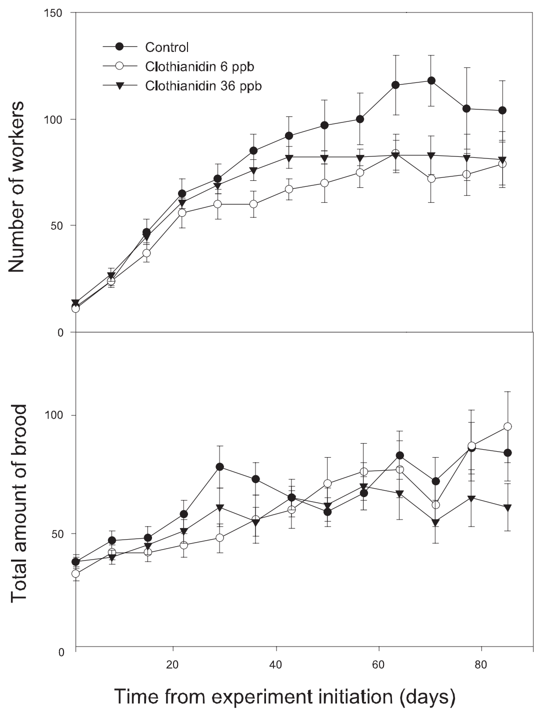

Fig. 2. Mean (±SE) number of workers and mean total amount of brood in eight *B. impatiens* colonies from each of the three treatments; control, 6 ppb clothianidin, and 36 ppb clothiandin.

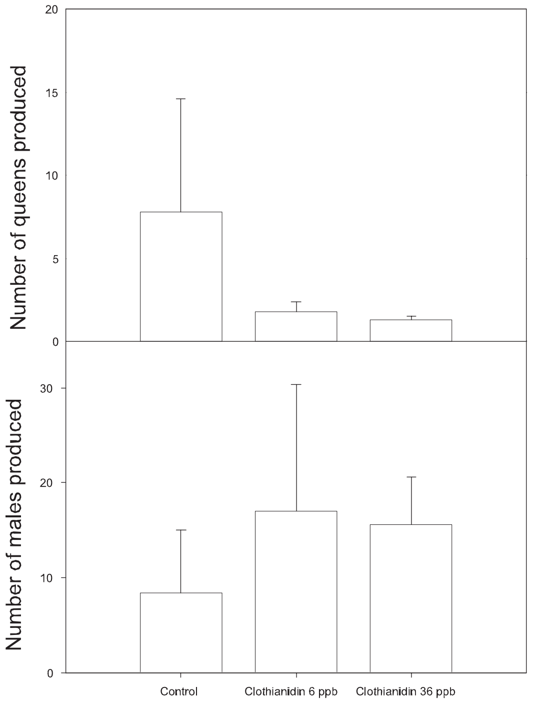

Fig. 3. Mean (±SE) total number of males and queens produced in eight *B. impatiens* colonies from each of three treatments; control, 6 ppb clothianidin, and 36 ppb clothianidin.

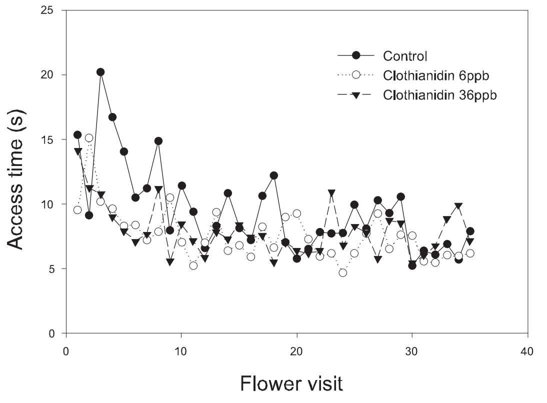

Fig. 4. Mean access times for flower visits 1–35 in three *B. impatiens* colonies from each of three treatments; control, 6 ppb clothiandin, and 36 ppb clothiandin. Foraging tests were performed on 18, 15, and 11 foragers, respectively. Access time measured the time a forager spent in contact with artificial complex flowers before successfully entering a flower and consuming the sucrose solution.

Foraging Assay. Fewer foragers were available to assess as the dose of clothianidin increased; however, the data collected was too sparse to quantify a potential pesticide effect. The mean access time (±SE) for flower visits 1–35 was 9.50 ± 1.29, 7.50 ± 0.37, and 8.00 ± 0.93 s in the control, 6 ppb clothianidin, and 36 ppb clothianidin treatments, respectively. The mean access time (±SE) for flower visits 1–10 was 13.11 ± 1.34, 9.34 ± 0.82, and 9.27 ± 0.77 s and for flower visits 20–35 was 7.59 ± 0.89, 6.67 ± 0.46, and 7.47 ± 0.86 s in the control, 6 ppb clothiandin, and 36 ppb clothianidin treatments, respectively. The interaction between the repeated measure of access time (1–35), round (1–3), and treatment was not significant (F = 0.85; df = 136, 10.6; P = 0.69). Overall, there was no difference in the mean access time between treatment groups (F = 2.42; df = 2, 35; P = 0.10; Fig. 4) or when visits were compared for flowers 1–10 (F = 2.64; df = 2, 4; P = 0.19) and 20–35 (F = 0.49; df = 2, 4; P = 0.64). The learning rate of foragers also was not different among treatments (F = 3.47; df = 2, 4; P = 0.13).

Discussion

We found that clothianidin did not harm bumble bee colony health at levels at or below 36 ppb in pollen and also had no detrimental sublethal effects on the foraging ability of worker bees. The doses of clothianidin we tested represented levels equal to or higher than those found in nectar and pollen of seed-treated crops. These results provide the first evidence that clothianidin residues will not harm bumble bees foraging on seed-treated crops and suggest that clothianidin may have less potential for impact on bumble bees compared with imidacloprid.

Consistent with our results, Scott-Dupree (personal communication) found clothianidin-treated canola with pollen and nectar residues between 0.9 and 3.7 ppb to have no effect on honey bee colony health. Imidacloprid, a neonicotinoid developed before clothianidin, has been tested more extensively on bumble bees and honey bees and has also been shown to have no detrimental effects at doses comparable with field exposure (Schmuck 1999, Schmuck et al. 2001, Morandin and Winston 2003). In contrast, some previously developed insecticides harm honey bee colony health at low doses (Johansen and Mayer 1990). For example, malathion and diazinon reduce honey bee longevity, and methoxychlor reduces brood rearing in honey bee colonies (Johansen and Mayer 1990). These results suggest that clothianidin and possibly other new generation neonicotinoids may pose less of a risk to the health of bumble bee colonies than earlier insecticides.

The foraging ability of workers was not affected by long-term exposure to 6 or 36 ppb clothianidin. Similar access times and learning rates were obtained for workers in each of the three treatments. In contrast, *B. impatiens* workers exposed to imidacloprid in a previous study with comparable testing procedures showed increased access times at doses of 30 ppb (Morandin and Winston 2003). This difference may reflect a modest reduction of neurotoxic symptoms induced by clothianidin relative to imidacloprid. Kiriyama and Nishimura (2002) compared the effects of these two compounds in the cockroach *Periplaneta americana* (L.) injected with 3 times the minimum lethal dose and observed trembling in cockroaches exposed to imidacloprid, whereas clothianidin caused no such effects. Suchail et al. (2000) found imidacloprid to induce trembling in honey bees after oral and contact exposure. In previous tests on imidacloprid, we observed trembling in *B. impatiens* workers exposed to levels of 30 ppb throughout their lifetime. In the current study, no trembling behavior was observed in foragers exposed to 6 or 36 ppb clothianidin. These results together suggest that clothianidin may have an increased margin of safety compared with imidacloprid at doses 6 to 10 times those found in treated crops.

The toxicity of many insecticides, in addition to application rate, is influenced by formulation and application method (Stark et al. 1995). Residue analysis may be of interest to determine levels in nectar and pollen of other selected crop species and in plants grown after soil or foliar treatments, because it is possible that levels higher than those tested in this study could be hazardous to bumble bee health and foraging ability. However, clothianidin and other chloronicotinyl compounds seem to offer safer alternatives for pest management than many earlier insecticides. In addition, the sensitive methods for testing sublethal foraging effects of insecticides that we used may allow compounds to be more accurately assessed for impacts on wild pollinators before being used on agricultural crops.

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Asian Longhorned Beetle Cooperative Eradication Program In New York and Illinois

ENVIRONMENTAL MONITORING REPORT 2003

Prepared by: Environmental Monitoring Team

TABLE OF CONTENTS

BACKGROUND

The Asian longhorned beetle (*Anoplophora glabripennis*), a non-native insect pest, entered the United States inside solid wood packing materials from China and was first detected in 1996 in Brooklyn, NY. Another infestation was discovered shortly thereafter on Long Island in Amityville, NY. In 1998, a separate infestation was found in Chicago, IL. Quarantine and eradication efforts established by the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS), in cooperation with the state Departments of Agriculture in New York and Illinois, have confined these beetle infestations to New York City area and Chicago.

As part of a cooperative eradication program, chemical treatments of non-infested host trees were conducted in 2000, 2001 and 2002. These prophylactic treatments involved the use of the chemical imidacloprid applied through either trunk or soil injections. Over the last three years, the number of host trees treated by trunk injection with imidacloprid was 158,187 in New York City and Long Island, while 55,954 trees were treated in the Chicago area. In 2002, soil injection was used extensively for the first time to treat non-infested host trees in Chicago. In Chicago, 30,843 trees were treated by soil injection. The soil injection treatment method has not been used operationally in New York.

ENVIRONMENTAL MONITORING

Once USDA-APHIS considers undertaking a pest control or eradication program, environmental documentation is developed to examine potential human health and environmental effects. Public meetings are also conducted to inform people about the proposed program and to solicit input. The environmental assessment for the Asian Longhorned Beetle (ALB) Program (USDA, APHIS 2000) and comments from the public provided guidance for the development of an environmental monitoring plan.

It is USDA-APHIS policy to conduct environmental monitoring as prescribed in APHIS Directive 5640.1 (Environmental Monitoring for APHIS Pest and Disease Control and Eradication Programs, revised 4/19/02), and in compliance with various federal statutes (e.g. National Environmental Policy Act; Endangered Species Act; Federal Insecticide, Fungicide and Rodenticide Act). Monitoring also demonstrates the Agency's commitment to environmental stewardship.

Environmental monitoring has been undertaken in both Chicago and New York since 2000 to address issues and concerns regarding potential exposure to imidacloprid and to establish whether there could be any risk to human health or the environment. A report describing monitoring efforts in Chicago in 2000 and 2001 and limited monitoring done in New York in 2001 was distributed in early 2002 (USDA, APHIS 2002). Below, previously unreported environmental monitoring done in New York in 2001 and 2002 and monitoring done in Chicago in 2002 are analyzed and interpreted.

MONITORING OBJECTIVES

Monitoring objectives were to estimate the potential for exposure of the public and non-target species to imidacloprid by:

1. evaluating the presence and persistence of imidacloprid in leaves and twigs of treated trees following trunk injection treatments;

2. evaluating the presence and persistence of imidacloprid in leaves, twigs and soil following soil injection treatments;

3. assessing the presence of imidacloprid in blossoms of treated trees that may be pollinated by bees;

4. determining whether stationary water near treated trees would become contaminated with imidicloprid residues from leaves that fall from treated trees and decompose in the water.

5. assessing the stability, precision and accuracy of imidacloprid formulations used for soil injections in Chicago through quality control procedures.

Objective 1: *Evaluate the presence and persistence of imidacloprid in leaves and twigs of treated trees following trunk injection treatments.*

Methods

Paired leaf and twig samples from eight different species of host trees in New York were sampled periodically for approximately one year after treatment for the presence of imidacloprid residues. These host species were Norway, sycamore, sugar and silver maple; poplar; elm; hackberry and mountain ash. The number of trees studied within each species varied; eight trees each of elm, poplar, Norway, silver and sycamore maples were sampled, along with six hackberry, four sugar maple and one mountain ash. Trees were treated by trunk injection using Mauget® capsule injectors (442.80 mg imidacloprid per capsule). One capsule was used for every 2 inches of tree diameter at breast height (dbh). Most trees were treated in the spring of 2001 and again in the spring of 2002. Procedures for sample collection and handling were detailed in the 2001 and 2002 Environmental Monitoring Plans (USDA, APHIS 2001a, USDA, APHIS 2001b).

Results

Raw data from leaf and twig samples collected from 51 trees in New York can be found in Appendix A by tree species. These data are summarized below in Tables 1, 2, 3 and 4.

Table 1 presents an overview of results. All data collected throughout the year-long sampling period were pooled. Of 265 twig samples, 50% contained quantifiable residues ranging from 0.1 to 1.5 mg/kg or parts per million (ppm). Of the remaining samples, 32% were negative and 18% contained residues but in concentrations so low (between

0.03 and 0.099 ppm) that they could not be reliably quantified. The average concentration of imidacloprid in twigs (n=265) was 0.19 ppm. Of 257 leaf samples, 75% contained quantifiable residues ranging from 0.1 to 12 ppm. Seventeen percent were negative and 8% had residues too low to quantify. The average concentration of imidacloprid in leaves (n=257) was 0.87 ppm.

Table 1. Residue Summary for Trunk Injected Trees in New York 2001-2002

	Twig Samples	**Leaf Samples**
number of samples	265	257
number with quantifiable residues	131	194
average residue concentration	0.19 ppm	0.87 ppm
minimum residue concentration	negative	negative
maximum residue concentration	1.5 ppm	12.0 ppm
median residue concentration	0.10 ppm	0.38 ppm
number of negative samples	84 (32%)	43 (17%)
number of non-quantifiable samples	49 (18%)	20 (8%)

Table 2 summarizes the persistence of imidacloprid in treated trees. Of the 51 trees sampled during this monitoring effort, 31 were sampled and resampled over approximately one year following treatment. Imidacloprid residues were found throughout the year in leaf samples from 28 of the 31 trees sampled. Twig samples from only 15 trees were positive for residues during the same time period. In the first sample period (at 3 months post-treatment), imidacloprid recovered in twig (n=15) and leaf samples (n =28) averaged 0.39 and 1.7 mg/kg, respectively. Twigs and leaves from these same trees still contained imidacloprid at one year post-treatment in average concentrations of 0.18 and 0.54 mg/kg, respectively. Residue concentrations in both twig and leaf samples declined over time as would be expected due to degradation and metabolism of imidacloprid in plant tissue. As supported by the literature (Chaney, 1986; Clifford, *et. al.* 1977; Tatter, 1998), imidacloprid does persist in most treated trees but appears to be distributed predominantly in the areas of the tree that are rapidly growing, such as leaves.

Not all of the 31 trees sampled were positive for imidacloprid throughout the one-year sampling period. Some twig (n=7) and leaf (n=2) samples contained residues early in the post-treatment period (within 3 months) but samples were negative after one year. Twig samples from 9 trees and leaf samples from 1 tree were negative for residues throughout the year-long sample period. There were no trees sampled that were negative at 3 months but positive at 1 year.

Table 2. Persistence of Imidacloprid Residues in Twig and Leaf Samples Trunk Injected Trees New York 2001-2002

	twig	leaf
samples positive for residues throughout one year	15	28
avg conc of imidacloprid within 3 months post-treatment	0.39	1.7
minimum conc	0.09	0.72
maximum conc	0.12	12.0
avg conc of imidacloprid at approximately 1 year post-trt	0.18	0.54
minimum conc	0.09	0.3
maximum conc	0.09	0.91
samples (+) within 3 months, but (-) after 1 year post-treatment	7	2
samples negative for residues throughout one year post-treatment	9	1
total number of trees sampled	31	

The data for all 51 trees sampled were also analyzed for presence of residues by tree species. Results for these samples by species can be found in Appendix A. Tables 3 and 4 provide a summary of residue data for the eight tree species by sample type (twigs and leaves, respectively).

Table 3. Residues in TWIGS by Tree Species	**Sycamore Maple**	**Elm**	**Norway Maple**	**Silver Maple**	**Sugar Maple**	**Poplar**	**Hackberry**	**Ash**
total twig samples	32	32	48	43	24	46	35	5
quantifiable residues	17	16	25	32	14	3	21	3
non-quantifiable residues	4	12	8	4	4	9	5	1
negative	11	4	15	3	6	34	10	1
trees sampled	8	8	8	8	4	8	6	1
% samples (+) for residues	66%	87%	69%	93%	75%	26%	71%	80%

Table 4. Residues in LEAVES by Tree Species	**Sycamore Maple**	**Elm**	**Norway Maple**	**Silver Maple**	**Sugar Maple**	**Poplar**	**Hackberry**	**Ash**
total leaf samples	32	30	48	42	23	46	31	5
quantifiable residues	24	23	37	33	20	34	19	4
non-quantifiable residues	3	1	4	4	0	7	1	0
negative	5	6	7	5	3	5	11	1
trees sampled	8	8	8	8	4	8	6	1
% samples (+) for residues	84%	80%	85%	88%	87%	89%	65%	80%

Uptake and distribution of imidacloprid in the trees were similar for most species. Residue results were combined regardless of time of collection (e.g. 3 months versus 12 months). For residues that could be quantified it appeared that imidacloprid was present in leaves in approximately 75% of the samples taken and in twigs in about 55% of the samples. This would be expected because leaves serve as a final sink for imidacloprid (Chaney, 1986; Clifford, *et. al.*, 1977; Tatter, 1998). Trees that were exceptions to this were poplar and hackberry. Although 74% of leaf samples contained quantifiable residues (the same as the other trees species), only 6% of twig samples from poplar trees contained quantifiable residues. In hackberry trees the distribution of chemical between leaves and twigs appeared to be equal with quantifiable residues of 60 % and 61% in twig and leaf samples, respectively. Residue data were not assessed based on tree size.

Lastly, persistence of imidacloprid in leaves that are loosing moisture and about to drop from treated trees in autumn has been considered, although not in this monitoring effort. Environmental monitoring in 2000 and 2001 examined residues in leaves sampled in the autumn just before dropping from treated trees. Generally, leaf samples that contained imidacloprid while green, retained some imidacloprid as they dried and dropped from the trees (USDA, APHIS 2002a). The highest residue in these leaves was 5 ppm. These data were used in the same monitoring report to assess potential exposure from inhaling smoke from dried leaves containing imidacloprid that had been raked and burned for disposal, and the possible exposure of children playing in dried, raked leaves containing imidacloprid. A summary of this work can be found later in this document in the Discussion Section.

Objective 2: *Evaluate the presence and persistence of imidacloprid in leaves, twigs and soil following soil injection treatments.*

Methods

Ten trees (five maple, four ash and one elm), not previously treated, were treated in Chicago in 2002 by soil injection as soon as the ground had thawed enough and were subsequently sampled. The maple trees were not differentiated by species (e.g. Norway, silver). Soil samples were collected just before treatments commenced and at 1 and 3 months post-treatment. Each soil sample was a composite of six inch cores taken near injection sites. Paired leaf and twig samples from these same trees were also collected 3 months after soil injection. Residue data from these leaf, twig and soil samples are summarized below and can be found in Appendix A.

Additional residue data were collected from eight trees (four willow and four box elder), previously treated by trunk injection and sampled in 2000 and 2001, but treated again by soil injection in 2002. Results from paired leaf and twig samples collected at 2 months post-treatment in 2002 are reported here. Residue data from these samples can also be found in Appendix A.

Results

Thirty soil samples were collected. All 10 pre-treatment soil samples were negative, as expected. Of the 20 soil samples collected post-treatment, imidacloprid was recovered in 8 samples. Five of these 8 samples contained residues in concentrations so low that they could not be reliably quantified (concentrations between 0.03 and 0.099 ppm). The other three samples contained imidacloprid at 0.5, 0.8 and 4.4 ppm, respectively. Six of the 8 positive samples were collected at 1 month post-treatment. The small sample size and low concentrations of imidacloprid in the samples provided insufficient information to make any conclusions regarding chemical degradation over time.

Ten twig and 10 leaf samples were collected from the same soil injected trees approximately 3 months after treatment. Leaf and twig samples from all 4 ash trees were negative. Of the 5 maple trees sampled, quantifiable residues were present in all leaf samples (0.16 to 0.63 ppm) and 3 twig samples (0.1 ppm each). The remaining 2 twig samples were negative. No residues were found in the leaf sample from the elm and only in low levels (non-quantifiable between 0.03 and 0.099 ppm) in the twig sample.

Twig and leaf samples were also collected from 4 willow and 4 box elder, 2 months after soil-injection. This was the third year of treatment for these trees. The trees had been treated by trunk injection in the first 2 years. Residues were recovered in leaf samples from 2 willow and 3 box elder (0.39 to 2.2 ppm). Residues in twig samples were recovered from only one box elder (0.3 ppm).

Samples from all the soil injected trees were collected 2 or 3 months after treatment, with no follow-up samples at 1 year, so persistence of imidacloprid in the trees following soil injection could not be evaluated. However, data from environmental monitoring from maple trees sampled in 2000 and 2001 examined residues in twigs (n=28) and leaves (n=28) from soil injected trees over one year post-treatment (USDA, APHIS 2002a). At 3 months post-treatment imidacloprid was present in 78% of twig and 100% of leaves sampled. Chemical was still quantifiably recovered in 75% of twig and 85% of leaf samples collected after one year post-treatment. Limited data indicates that persistence of the chemical in soil injected trees does occur for at least one year after treatment.

Objective 3: *Assess the presence of imidacloprid in blossoms of treated trees that may be pollinated by bees.*

Methods

Blossoms from 20 trees that could potentially be pollinated by bees (6 Norway maple, 5 silver maple, 1 sugar maple and 8 horsechestnut) were sampled in early spring 2002 as trees were blooming. All trees had been treated by trunk injection approximately 10 to 12 months earlier in 2001. Twelve of the original 20 trees were sampled again in the early spring of 2003. Eleven of these 12 trees had been re-treated by trunk injection approximately 10 to 12 months earlier in 2002.

Results

Of 32 blossom samples collected, only one contained quantifiable residues (0.13 ppm). Four other samples (12%) contained residues so low they could not be reliably quantified (concentrations between 0.099 and 0.030 ppm). All other samples were negative. Residue data from these samples can be found in Appendix A.

Objective 4: *Determine whether stationary water near treated trees would become contaminated with residues from leaves that fall from treated trees and decompose in the water.*

Methods

One pond within the Corona Park Zoo in NY was sampled following treatments of trees near the pond. The pond was approximately 1 acre in size and ranged in depth from 2 to 7 feet. There were approximately 50 trees within 100 feet of the pond which had been treated by trunk injection in the spring of 2000, 2001 and 2002. Trees were in close proximity to the pond such that many falling leaves from the treated trees were likely to reach the pond. The pond was sampled in the fall of 2000, the spring of 2001 and the spring of 2002. Monitoring was limited to only one pond because other bodies of stationary water were not found within treatment areas.

Results

Only 3 water samples were collected at the Corona Park Zoo pond (one each year) and all 3 samples were negative. Additional information can be found in Appendix A.

Objective 5: *Assess the stability, precision and accuracy of imidacloprid formulations used for soil injections in Chicago through quality control procedures.*

Quality Control procedures were developed at the request of program personnel in Chicago to assess the stability, precision and accuracy of imidacloprid formulations used for soil injection in 2002. Several chemical tank trucks were used each day to provide imidacloprid for soil injections. Tanks were filled each day with a mixture of imidacloprid and water which was used throughout a work day. Several different types of samplings were conducted to assure tank mixes produced the proper concentration of chemical for soil injection treatments.

1. When treatments began in Chicago chemical truck tanks were filled each day with a mixture of a wettable powder formulation of imidacloprid (Merit 75 WP) and water. Tanks were sampled during calibration to determine whether all tank mixes resulted in a product that was consistently close to expected concentrations. Table 5 contains results from the wettable powder formulation (Merit 75 WP) samples.

Table 5. Quality Control Samples Wettable Powder Formulation (Merit 75 WP) of Imidacloprid

Truck Identification	Date Collected	Results (ppm)	% of Expected Recovery[1]
31 669H	3-18-02	635	84.8
35 69H		602	80.7
39 907H		665	88.8
41 131H		609	81.3
46 111		669	89.3
55 960D		694	92.7
6469H		662	88.4

[1]Tank mix should result in 748.93 parts per million imidacloprid (100% recovery). % of Expected Recovery is the percentage of the analytical result compared to the expected concentration of 748.93 ppm.

Results indicate that tank mixes resulted in imidacloprid concentrations that were consistently less than expected. It is unknown why these results were low; perhaps tank mixes were not being thoroughly agitated, allowing for the chemical suspension to settle out.

2. A series of timed samples were collected from two tank trucks to establish whether continuous mixing produced a homogenous product and one that contained the expected concentration of 748.93 ppm throughout the day. Table 6 below shows the results of this sampling.

Table 6. Recovery of Imidacloprid from Tank Mix Samples During a Treatment Day

Truck Identification	Comments	Date Collected	Results	% of Expected Recovery[1]
Truck #46111	Tank 2 initial mix; sample taken after 10 minutes of agitation	3-26-02	582 ppm	77.7
	Tank 2 sample at start of treatment; 10 minutes of agitation		579 ppm	77.3
	Tank 2 sample taken halfway thru treatment; 3 hours of agitation		563 ppm	75.2
	Tank 2 sample taken at end of treatment; 4.5 hours of agitation		1520 ppm	202.9
Truck #46111	Tank 1 sample taken after mixing; 5 minutes of agitation	4-23-02	741 ppm	98.9
	Tank 2 sample taken at start of treatment; 2 hours of agitation		642 ppm	85.7
	Tank 2 sample taken halfway thru treatment; 4 hours of agitation		690 ppm	92.1
	Tank 2 mixed with product from Tank 1; 5 hours of agitation		702 ppm	93.3
	Tank 2 sample taken at end of treatment; 9 hours of agitation		719 ppm	96.0

[1]Tank mix should result in 748.93 parts per million imidacloprid (100% recovery). % of Expected Recovery is the percentage of the analytical result compared to 748.93 ppm.

Samples from 3-26-02 were consistently below the expected concentration. The final sample that day was extremely high, indicating that the wettable powder was probably never fully in suspension. There may have been little agitation of the tank mix when this sample was collected. Samples taken on 4-23-02 were much closer to the expected concentration. Samples were more homogeneous although there was still some variability which could be attributed to the sampling process, the agitation process or the ability to recirculate the tank mix. An acceptable range of concentrations were not established, however, it would appear that all but one sample were between 92 - 99% of the expected concentration.

3. The stability of tank mixes over time was examined. Three different tank mixes were sampled from contractor's trucks during calibration and prior to treatment. The sample from each tank mix was divided into three aliquots. The first aliquot was sent to the APHIS Analytical and Natural Products Chemistry Laboratory (ANPCL) in Gulfport, MS

analysis by overnight mail for immediate analysis. The second and third aliquots were kept at room temperature for 9 and 14 days, respectively and then sent to ANPCL for analysis. Table 7 has the results of this abbreviated stability study.

Table 7. Stability of Imidacloprid from Tank Mix Samples

Truck Identification	Sample Identification	Date Collected	Results	% of Expected Recovery[1]
# 33 488H	1st sample (1 day old)	3-18-02	700 ppm	93.5
	2nd sample (9 days old)		691 ppm	92.3
	3rd sample (14 days old)		688 ppm	91.0
# 35 341H	1st sample (1 day old)	3-18-02	652 ppm	87.1
	2nd sample (9 days old)		684 ppm	91.3
	3rd sample (14 days old)		721 ppm	96.3
# 8883	1st sample (1 day old)	3-18-02	636 ppm	84.9
	2nd sample (9 days old)		659 ppm	87.9
	3rd sample (14 days old)		678 ppm	90.5

[1]Tank mix should result in 748.93 parts per million imidacloprid (100% recovery). % of Expected Recovery is the percentage of the analytical result compared to 748.93 ppm.

It would appear that the wettable powder formulation of imidacloprid, once mixed with water, does not degrade significantly over at least a 14 day period. Thus, for operational procedures, tank mixes may be prepared the night before treatment commences (or even several days before use). If some chemical remains in a tank after a day's treatment, the concentration should remain stable for at least 14 days as long as the tank mix is thoroughly agitated again before use. Product chemistry from the manufacturer supports these results as long as the chemical is not exposed to sunlight.

4. The program managers modified operations and moved from using the wettable powder formulation (Merit 75 WP) to a flowable formulation of imidacloprid (Merit 2). The flowable formulation was expected to be more miscible and thus remain in suspension better. Table 8 contains results from samples of truck tanks which contained the flowable formulation (Merit 2).

Table 8. Quality Control Samples
Flowable Formulation (Merit 2)of Imidacloprid

Truck Identification	Date Collected	Results (ppm)	% of Expected Recovery[1]
13 318	4-12-02	727	95.8
46 111		677	89.2
31 669		1008	132.8
11 044		778	102.5
6469		733	96.6
55 960		666	87.8
33 488		745	98.2
10 476		678	89.3
35 691		756	99.6
35 341		690	90.9
39 907		1478	194.7
2269		1314	173.1
8893		764	100.6
41 131		772	101.7
13971	4-22-02	662	87.2
8151		815	107.4
7950		828	109.1
27 691		748	98.6
42 575		779	102.6
41 143		785	103.4

[1]Tank mix should result in 758.94 parts per million imidacloprid (100% recovery). Expected recovery is the percentage of the analytical result compared to the expected concentration of 758.94 ppm.

Concentrations of imidacloprid in tank mixes of Merit 2 were variable. It was hoped that this flowable formulation (containing surfactants) would result in more consistent concentrations of chemical. However, imidacloprid was present in tank mixes ranging from 87% to 195% of expected concentrations. The cause of this variability is unknown.

DISCUSSION

A discussion of risk was presented in the earlier environmental monitoring report (USDA, AHIS 2002). The discussion below expands on that report to include the information derived from treated trees in New York in 2001 and 2002 and in Chicago in 2002.

Risk is a function of several factors: the toxicity of the chemical; the likelihood of exposure to the chemical; the amount of the exposure (or dose); and the duration of exposure.

Toxicity: Imidacloprid is considered by the United States Environmental Protection Agency (EPA) to be a reduced-risk pesticide (Felsot, 2001). It is in a class of pesticides known as chloronicotinyl nitroguanidines. Their action is nicotine-like but much less toxic than nicotine (Felsot, 2001; OSU Extension Extoxnet, 2001; OSU Extension NPIC, 2001). Imidacloprid acts by disrupting the nervous system of insects. It acts as a competitive inhibitor at nicotinic acetylcholine receptors on the nerve cells of insects. The result is that signals from one nerve cell to another are blocked and normal nerve function is impaired. Imidacloprid has a higher binding affinity for insect nerve cell receptor sites than for mammalian receptor sites so it is much more toxic to insects than warm-blooded animals.

Data from studies submitted to EPA by the chemical company as part of the product registration process also demonstrate low toxicity to humans and other non-target species. As a result, the EPA classified, Imicide®, the formulation of imidacloprid used in trunk injections, in the lowest class for toxicity; class III. This requires only a "Caution" word to be on the label.

Exposure: Exposure to any chemical can occur through inhalation, contact and absorption through the skin, or by ingestion. Imidacloprid has a low vapor pressure which indicates that it is relatively non-volatile, so imidacloprid is unlikely to be present in the air during or after ALB treatments. Work from earlier environmental monitoring supports this (USDA, APHIS; 2002a). In leaves collected in the autumn, just prior to dropping from trees, residues ranged from 5 ppm in the leaves from trees treated in Chicago, to as much as 100 ppm imidacloprid from the experimental trees in Massachusetts. Once residue levels were determined, the leaves were burned, all smoke samples were analyzed and found to be negative for imidacloprid residues. Imidacloprid was not present in the smoke. Thus, residents that might inhale smoke from the burning of leaves containing imidacloprid would not be exposed to any chemical residue. There is no risk of exposure to imidacloprid from treated trees through inhalation of smoke or from the chemical volatilizing into the air following a treatment.

Contact and absorption of the chemical through the skin is also unlikely because the chemical is either injected through the bark into the tree or injected into the soil to be taken up by the root system. Once taken into the tree imidacloprid is transported through the xylem to the growing plant tissues. Imidcloprid is contained within the tree. It should not be present on the outside of the leaves or tree bark so there should be no dislodgeable residue available for dermal contact. Contact with sap or treated soil are the only likely routes of dermal exposure. Dermal exposure to sap could occur if leaves or twigs are broken and sap is released. Preliminary research conducted by APHIS scientists on trees in Massachusetts, which were treated in 2000 following the same procedures for trunk injection, have shown that imidacloprid was not present in sap when samples were collected the following spring (Personal Communication, David Cowan, 2001). However, additional data is being collected to look for residues in sap to fully explore this possibility. Dermal exposure to imidicloprid treated soil will be discussed below in combination with exposure through ingestion.

Exposure through ingestion would occur only if tree tissue or treated soil were eaten. These routes of exposure are evaluated below.

Dose: Residue data derived from environmental samples provides the basis for estimating dose. Three years of environmental monitoring has resulted in the accumulation of residue data from over 1600 samples (826 twig, 791 leaf , 51 blossom, 77 soil and 3 water samples). Trees have been treated predominantly by trunk injection but soil injection has been done as well. Residue information from these samples can be considered as potential doses following an exposure. Exposure scenarios described in Appendix B take into account these residue concentrations, which are then used to assess risk.

Distribution and persistence of imidacloprid in treated trees and soil can be examined in relation to potential dose. Uptake and distribution of imidacloprid appears to vary from tree species to tree species as noted in this report and in the Environmental Monitoring Report for the Asian Longhorned Beetle Cooperative Eradication Program 2000-2001 (USDA, APHIS 2002). However, in all tree species, imidacloprid residues are present more frequently, in greater concentrations, and for a longer period of time in leaf samples than in twig samples. Leaves from treated trees will be most likely to contain residues, higher residues and for a longer period of time. Therefore leaf sample residues will be used for the conservative estimate of dose in this risk assessment.

Imidacloprid is taken up by trees more rapidly when trunk injection is used. However, the chemical appears to remain longer *in situ*, or is taken up over a longer period of time, following soil injection. When imidacloprid was recovered in samples from trunk injected trees, residue was present within one month following treatment. The highest concentrations of imidacloprid were usually also present after one month following treatment. In trees that were treated by soil injection, root uptake and distribution to leaves and twigs of the canopy required at least 4 to 6 weeks after treatment before residues were detected in most samples. By the end of a treatment year most imidacloprid was below quantifiable levels in samples taken from trees that were trunk injected. However, of the trees treated by soil injection and sampled for over a year (USDA, APHIS, 2002) chemical was still quantifiably recovered in 75% of twig and 85% of leaf samples collected, although concentrations were lower than at one month post-treatment. These results are similar to work of others comparing the two treatment methods (Tattar, 1998; Gill, 1999). So, potential exposure to leaves containing imidacloprid could occur as soon as one month after trunk injection or a bit longer following soil injection. Imidacloprid persists in leaf tissue for a longer period of time in trees treated by soil injection and so potential exposure could occur at least 12 months following treatment, however imidacloprid concentrations diminish over time.

Leaf and Twig Samples: Imidacloprid residues recovered in samples collected during this monitoring effort are similar to residues in samples described in an earlier report (USDA, APHIS 2002). The complete database for leaf and twig residue now comprises 791 leaf and 826 twig samples collected in 2000, 2001, 2002 and 2003 from New York and Chicago. Twelve different tree species were sampled. Residues were recovered in leaf and twig samples from trees treated by trunk injection or soil injection; from trees treated only once to trees treated 3 years in a row. This database provides enough residue information to strengthen the evaluation of risk to the environment and human health.

Of all trees sampled, regardless of treatment method, 54% of twigs and 28% of leaves had no detectable residues. Those with a trace (non-quantifiable) amount of residues comprised 15% twigs and 9% leaves. Measurable residues were found in 31% twig and 63% leaf samples. When imidacloprid was present in quantifiable levels, residues in twig samples ranged from 0.1 to 2.9 ppm and in leaf samples from 0.1 to 40 ppm and averaged 0.3 and 1.2 ppm in twigs and leaves, respectively. Median concentrations were 0.23 ppm in twigs and 0.41 ppm in leaves. In both leaf and twig samples, residues were highest within the first 1-3 months after treatment so this would be the time period of highest potential exposure. Residue concentrations in both leaf and twig samples then begin to decline over time due to degradation and metabolism of imidacloprid in plant tissue.

Using this monitoring data and standard assumptions from EPA (USEPA, 1999b; USEPA, 2000), scenarios were developed in Appendix B to examine possible risk to human health and the environment. Exposure and dose scenarios include the outcome and potential risk to small children playing in and eating leaves from treated trees, squirrels eating nuts from treated trees and birds eating insects that have ingested leaves from treated trees. Based on the results of these scenarios margins of safety for children were 5 to 50 times greater than the EPA's safe exposure levels. Margins of safety for other species were 5 to 94 times greater than the estimated safe dose for that species. It is evident that the methods of treatment confining imidacloprid to limited areas in the environment, for a limited time, and the small amount of chemical found in leaf and twig samples, combined with the low toxicity of imidacloprid, provide little risk to the environment or human health and safety.

Soil Samples: Migration of imidacloprid to the soil surface was reported in one study where imidacloprid was delivered in a subsurface drip irrigation system (Felsot et al, 1998). On occasion, imidacloprid was recovered near the soil surface, above the application depth. Researchers believed that imidacloprid was carried to the soil surface by the water used in the irrigation system. However, these conditions did not exist for ALB treatments in Chicago so migration of imidacloprid was not expected. During treatments in Chicago, soil injection depth was permitted to vary from 4 to 12 inches. The positive soil samples in this study probably represent soil injections done at the shallower depth or as a result of back-flow through the injection hole.

Depending on soil composition and time of residence in soil, imidacloprid shows intermediate to low mobility in soil. The highest sorption, or ability to bind to soil or other material, has been demonstrated in soils with a high clay and high organic content (Cox, 1998a, Cox 1998b, Cox 1997, Capri 2001, Oliveira 2000). Soils in Chicago are high in clay content, so binding of imidacloprid to the soil would be expected. Sorption or binding to the soil increases with aging thereby making imidacloprid more resistant to leaching. Thus, the one sample containing 4.4 ppm 3 months after treatment probably represents an area that received a direct injection of imidacloprid rather than the migration of the chemical from the injection site. If there was some migration of imidcacloprid in the soil, it was not extensive and as aging increased, would become less likely to leach from the site. There was too little data to conclude whether the detected residues were due to migration or sampling from shallow injection sites.

Potential risk following exposure to treated soil was considered. Exposure through ingestion or dermal absorption might occur with children exhibiting pica (a behavior involving ingestion of unusually high amounts of soil) or digging in the soil under treated trees. Domestic pets, birds and other wild animals that dig or root in the soil might also be exposed to imidacloprid through contact with the soil. Exposure scenarios for small children eating soil and playing in soil are described in Appendix B.

Using data from this limited number of soil samples, margins of safety for pica and playing in soil are 50 and 25,000 times greater, respectively, than the EPA reference dose. If samples had been collected sooner than 3 months post-treatment it is possible that residues would have been higher since imidacloprid in soil has a half-life of 28.7 to 44.3 days based on several agricultural field studies (Rouchaud, *et. al.*, 1994; Sarkar, 2001). These results may not represent the most conservative exposure potential but even if concentrations were doubled there would still be large margins of safety. It can be concluded that there is little risk to human health or non-target species from exposure to soil containing the concentrations of imidacloprid (as much as 4.4 ppm imidacloprid) recovered from this monitoring effort.

Blossom Samples: The oral LD_{50} of imidacloprid for bees is between 4 and 41 nanograms per bee (Schmuck et al, 2001). This translates to a nectar or pollen concentration of between 0.14 and 1.5 mg/kg (Schmuck et. al., 2001). However, in a study conducted by researchers in Washington State, honey bees fed syrup with 2 mg/kg imidacloprid only reduced their visits to the feeder by 7% (Mayer and Lunden, 1997). If the reduction in visits reflects mortality this was not considered a significant impact on a hive. Monitoring data shows that 5 of 32 blossom samples collected contained imidacloprid residues. One sample contained 0.13 mg/kg while residues from the other 4 samples were so low that they could not be reliably quantified (<0.099 mg/kg). The one sample that was quantified approached the lower concentration of concern of 0.14 mg/kg. Thus, based on this monitoring effort, it is possible that some bee mortality could occur from exposure to tree blossoms containing pollen with imidacloprid residues.

Pond Water Samples: Only 3 samples were collected from the Corona Park Zoo duck pond. At each sampling period the pond contained leaves from nearby trees. All trees near the pond had been treated with imidacloprid by trunk injection, however, residue information from the leaves of those trees was not obtained. Although the sample size was quite small and leaf residue data was not collected, it would appear that imidacloprid was not released into water following decomposition of leaves. It is possible that some of the leaves in the pond did not contain imidacloprid, but it is unlikely that all the leaves in the pond, coming from several treated trees, were all negative for residues.

Summary: As described earlier, risk posed by any chemical is related to the likelihood of exposure, the amount of the exposure (dose), the duration of the exposure, and the actual toxicity of the chemical. The toxicity of imidacloprid has been discussed. Program treatment procedures using either trunk or soil injection limit exposure. Trunk injections comprise a closed system. Imidacloprid is contained in a sealed injector capsule which is inserted through the bark directly into a tree. Soil injections are applied 4 - 12 inches under the soil and exposure is limited to contact with treated soil by people or animals digging down into the soil. Imidacloprid is taken up by a treated tree and confined within the tree to plant tissue. Thus, the likelihood of exposure to the chemical during and following treatment is very low because it is related to contact with treated trees or surrounding soil following soil-injection. The dose and extent of the exposure was estimated using residue data generated from environmental monitoring. Taking all these factors into account there is little or no risk to the general public, including children, and the environment as a result of Program imidacloprid treatments of trees in Chicago and New York.

CONCLUSIONS

Based on 3 years of environmental monitoring the following conclusions can be drawn.

- Using data from over 1600 samples, there is no risk to the general public, including children, and little or no risk to the environment as a result of Program imidacloprid treatments of trees in Chicago and New York. This is due to the reduced-risk nature of imidacloprid, the methods of treatment (trunk or soil injection) and the low concentrations of chemical recovered in monitoring samples.

- Imidacloprid was rapidly transported in trees that were treated by trunk injection (within 4 weeks). Uptake by the root system and transport was slower (>4 weeks) in trees treated by soil injection.

- Distribution of the chemical throughout the tree canopy varied from species to species likely due to variation in the physiology of tree vasculature.

- Uptake of imidacloprid resulted in low concentrations of the chemical being present in leaves and twigs. Concentrations were predominantly below 1 ppm.

- Chemical uptake occurs throughout the tree but can be found in leaf samples more often than in twig samples for most species of trees sampled. Imidacloprid tends to follow the typical route of water and nutrients by migrating towards areas of the tree that are rapidly growing, such as leaves.

- Imidacloprid does persist in most trees treated by trunk and soil injection for at least 12 months after treatment, although a decrease in imidacloprid concentrations in leaves and twigs occurred over time.

- Quality control of tank mixes indicated that imidacloprid is stable upon mixing with water for at least 14 days. Concentrations of imidacloprid in both the Merit 75 WP and Merit 2 formulation were more variable than expected.

RECOMMENDATIONS

The possibility of leaves from treated trees decomposing in stationary water and releasing imidacloprid should be examined further. If additional water bodies near treated trees become available, monitoring for residues in the water should be conducted.

The potential for soil-injected imidacloprid to leach from the soil and to reach groundwater should be examined. It is recommended that a controlled study be undertaken to address this issue in an area where drinking water could not be compromised. This study should be conducted, rather than to wait to collect monitoring samples in the event that program soil treatments occur in an area where wells are in proximity and ground water could be potentially at risk.

No other environmental monitoring should be required for imidicloprid applied by trunk or soil injection.

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APPENDIX A

RESIDUE DATA

ALB Program in New York 2001 – 2002
Norway Maple Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Amityville #16	26.5	7/5/01	7/31/01	1st trt - 1	bld[1]	bld
			10/9/01	3	0.24	3.8
			11/8/01	4	0.38	1.3
			6/1/02	11	0.17	0.48
		6/14/02	9/5/02	2nd trt - 3	0.64	3.7
			10/17/02	4	0.36	2.2
Amityville #21	18.5	7/2/01	7/31/01	1st trt - 1	bld	3
			10/10/01	3	0.24	1.2
			11/14/01	4	0.38	0.5
			5/31/02	11	0.12	0.42
		6/13/02	9/5/02	2nd trt - 3	0.15	1.5
			10/17/02	4	0.1	1.4
Amityville #22	21.5	7/2/01	7/31/01	1st trt - 1	0.55	1.7
			10/9/01	3	blq[2]	0.47
			11/8/01	4	0.23	1.1
			5/31/02	11	blq	0.18
		6/13/02	9/5/02	2nd trt -3	bld	blq
			10/17/02	4	blq	0.27
Amityville #23	19	7/2/01	7/31/01	1st trt - 1	0.12	0.76
			10/9/01	3	bld	bld
			11/8/01	4	blq	0.74
			5/31/02	11	0.1	0.3
		6/13/02	9/5/02	2nd trt - 3	blq	0.3
			10/17/02	4	bld	blq
Amityville #24	23.25	7/2/01	7/31/01	1st trt - 1	0.28	1.8
			10/9/01	3	0.45	2.1
			11/8/01	4	0.36	1.2
			5/31/02	11	0.19	0.26
		6/13/02	9/5/02	2nd trt - 3	bld	bld
			10/17/02	4	blq	0.4

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[2]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

ALB Program in New York 2001 – 2002
Norway Maple Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Amityville						
#25	26.25	7/2/01	7/31/01	1st trt - 1	0.21	1.2
			10/9/01	3	bld	0.64
			11/8/01	4	blq	0.5
			5/31/02	11	0.15	0.43
		6/13/02	9/5/02	2nd trt - 3	bld	0.23
			10/17/02	4	blq	0.69
Amityville						
#26	12.5	7/5/01	7/31/01	1st trt - 1	bld	bld
			10/9/01	2	bld	bld
			11/8/01	3	bld	bld
			6/1/02	11	bld	bld
		6/14/02	9/5/02	2nd trt - 3	0.46	3.6
			10/17/02	4	0.11	0.19
Amityville						
#27	12.5	7/5/01	7/31/01	1st trt - 1	0.16	1.3
			10/9/01	2	bld	blq
			11/8/01	3	bld	0.66
			6/1/02	11	bld	blq
		6/14/02	9/5/02	2nd trt - 3	0.15	1.2
			10/17/02	4	0.11	0.88

ALB Program in New York 2001 - 2002
Sycamore Maple Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Central Park CPSM#1	18.25	5/30/01	8/16/01	1st trt - 3	0.24	7.2
			11/07/01	5	blq	blq
		5/5/02	9/3/02	2nd trt - 4	0.11	1.4
			10/25/02	6	blq	bld
Central Park CPSM#2	26.25	5/30/02	8/16/01	1st trt - 3	0.15	1.7
			11/7/01	5	bld	blq
		5/5/02	9/3/02	2nd trt - 4	0.15	1.4
			10/25/02	6	bld	0.18
Central Park CPSM#3	11.5	5/30/02	8/16/01	1st trt - 3	0.14	2.7
			11/7/01	5	bld	blq
		5/5/02	9/4/02	2nd trt - 4	0.33	1.3
			10/25/02	6	bld	0.21
Central Park CPSM#4	29.75	5/30/02	8/16/01	1st trt - 3	0.18	5.2
			11/7/01	5	bld	0.23
		5/5/02	9/3/02	2nd trt - 4	blq	2.7
			10/25/02	6	bld	0.41
Central Park CPSM#5	13.5	5/30/02	8/16/01	1st trt - 3	0.77	4.2
			11/7/01	5	bld	bld
		5/5/02	9/4/02	2nd trt - 4	0.55	1.5
			10/25/02	6	bld	bld
Central Park CPSM#6	19.5	5/30/02	8/16/01	1st trt - 3	0.13	1.1
			11/7/01	5	bld	bld
		5/5/02	9/4/02	2nd trt - 4	0.2	2.6
			10/25/02	6	0.32	0.53
Central Park CPSM#7	26	5/30/02	8/16/01	1st trt - 3	bld	bld
			11/7/01	5	0.16	1.3
		5/5/02	9/4/02	2nd trt - 4	0.23	0.67
			10/25/02	6	0.25	1.2
Central Park CPSM#8	18.75	5/30/02	8/16/01	1st trt - 3	0.2	3.9
			11/7/01	5	bld	0.3
		5/5/02	9/4/02	2nd trt - 4	0.21	1.5
			10/25/02	6	blq	0.66

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[2]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

ALB Program in New York 2001 - 2002
Silver Maple Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Socrates Sculpture Park #4	18.5	5/2/01	7/30/01	1st trt - 3	0.34	0.43
			10/11/01	5	0.21	0.25
			11/6/01	6	bld[1]	bld
			5/31/02	13	bld	0.26
		6/3/02	10/18/02	2nd trt - 4	na[2]	blq[3]
Socrates Sculpture Park #9	13.5	5/2/01	7/30/01	1st trt - 3	bld	0.12
			10/11/01	5	blq	blq
			11/6/01	6	0.11	bld
			5/31/02	13	blq	0.25
		6/3/02	8/30/02	2nd trt - 3	0.065	0.22
			10/18/02	4	blq	bld
Socrates Sculpture Park #10	8	5/2/01	7/30/01	1st trt - 3	0.55	0.89
			10/11/01	5	0.48	0.75
			11/6/01	6	0.15	0.64
		6/3/02	8/30/02	2nd trt - 3	0.12	0.65
			10/18/02	4	0.47	0.2
Amityville #17	25.25	7/3/01	7/31/01	1st trt - 1	0.36	1.3
			10/10/01	3	0.24	bld
			11/14/01	4	0.27	bld
		6/13/02	9/6/02	2nd trt - 3	1.2	0.99
			10/17/02	4	0.17	blq
Amityville #18	27.5	7/3/01	7/31/01	1st trt - 1	0.38	1.5
			10/10/01	3	1.4	0.56
			11/14/01	4	0.51	blq
		6/13/02	9/6/02	2nd trt - 3	0.87	2.3
			10/17/02	4	0.11	0.6

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[2]na means sample was not analyzed.

[3]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

ALB Program in New York 2001 – 2002
Silver Maple Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Amityville #19	25.75	7/3/01	7/31/01	1st trt - 1	0.18	1.3
			10/10/01	3	0.17	0.22
			11/14/01	4	0.97	0.32
		6/13/02	9/6/02	2nd trt - 3	0.26	0.71
			10/17/02	4	0.26	0.33
Amityville #20	28	7/3/01	7/31/01	1st trt - 1	1	7.2
			10/10/01	3	0.41	3.4
			11/14/01	4	0.37	1.2
			6/14/02	11	0.18	0.24
		6/14/02	9/5/02	2nd trt - 3	0.25	1.6
			10/17/02	4	0.17	na[1]
Lindenhurst #29	26	6/5/01	8/1/01	1st trt - 2	1.5	5.6
treated only once			10/16/01	4	0.28	1.2
			11/12/01	5	0.59	1.2
			6/26/02	13	0.35	0.93
			9/9/02	15	0.21	0.62
			10/17/02	16	0.24	0.63

[1]na means sample was not analyzed.

ALB Program in New York 2001 - 2002
Sugar Maple Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Amityville #12	17	7/3/01	7/31/01	1st trt - 1	0.46	0.81
			10/9/01	3	0.21	3.3
			11/8/01	4	0.45	3
			5/31/02	11	0.24	0.48
		6/13/02	9/5/02	2nd trt - 3	0.6	0.97
			10/17/02	4	0.48	0.97
Amityville #13	28	7/3/01	7/31/01	1st trt - 1	bld[1]	0.015
			10/9/01	3	0.67	3.3
			11/8/01	4	blq[2]	0.41
			5/31/02	11	blq	0.24
		6/13/02	9/5/02	2nd trt - 3	0.15	0.46
			10/17/02	4	blq	0.36
Amityville #14	23	7/3/01	7/31/01	1st trt - 1	bld	0.33
			10/9/01	3	0.35	1.3
			11/8/01	4	0.46	ns[3]
			5/31/02	11	bld	0.19
		6/13/02	9/5/02	2nd trt - 3	0.32	0.93
			10/17/02	4	0.23	0.25
Amityville #15	30	7/5/01	7/31/01	1st trt - 1	bld	0.015
			10/9/01	3	0.1	0.5
			11/8/01	4	blq	0.13
			6/1/02	11	bld	0.015
		6/14/02	9/5/02	2nd trt - 3	bld	0.27
			10/17/02	4	0.14	0.44

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[2]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

ALB Program in New York 2001 - 2002
Elm Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Central Park CPE#1	19.5	5/9/01	8/16/01	1st trt - 3	blq[1]	0.48
			11/17/01	6	bld[2]	ns[3]
		5/5/02	9/10/02	2nd trt - 4	blq	0.58
			10/24/02	6	0.12	0.36
Central Park CPE#2	31.5	5/9/01	8/16/01	1st trt - 3	0.22	1
			11/7/01	6	0.25	0.38
		5/5/02	9/10/02	2nd trt - 4	0.22	1.2
			10/24/02	6	0.38	0.26
Central Park CPE#3	35.75	5/9/01	8/16/01	1st trt - 3	blq	bld
			11/7/01	6	bld	bld
		5/5/02	9/10/02	2nd trt - 4	blq	bld
			10/24/02	6	blq	0.2
Central Park CPE#4	38	5/9/01	8/16/01	1st trt - 3	0.12	0.49
			11/7/01	6	blq	0.43
		5/5/02	9/10/02	2nd trt - 4	0.18	0.8
			10/24/02	6	blq	0.19
Central Park CPE#5	29.25	5/9/01	8/11/01	1st trt -3	0.11	0.56
			11/7/01	6	0.21	ns
		5/5/02	8/28/02	2nd trt - 4	0.24	1.2
			10/24/02	6	0.2	0.71
Central Park CPE#6	35	5/9/01	8/16/01	1st trt - 3	blq	0.41
			11/7/01	6	blq	0.12
		5/5/02	8/28/02	2nd trt - 4	0.25	1.8
			10/24/02	6	0.23	0.63
Central Park CPE#7	60	5/9/01	8/16/01	1st trt - 3	blq	0.57
			11/7/01	6	blq	blq
		5/5/02	9/10/02	2nd trt - 4	blq	bld
			10/24/02	6	0.28	0.15
Central Park CPE#8	60	5/9/01	8/16/01	1st trt - 3	bld	bld
			11/7/01	6	bld	bld
		5/5/02	9/4/02	2nd trt - 4	0.22	0.73
			10/24/02	6	0.13	0.27

[1]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

[2]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[3]ns means no sample was collected; leaves had already fallen off the tree.

ALB Program in New York 2001 – 2002
Poplar Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Socrates Park #1	26.25	5/2/01	7/30/01	1st trt - 3	bld[1]	0.37
			10/11/01	5	bld	bld
			11/6/01	6	bld	bld
			5/31/02	13	bld	0.064
		6/3/02	10/18/02	2nd trt - 4	bld	bld
Socrates Park #2	16.25	5/2/01	7/30/02	1st trt - 3	0.064	0.81
			10/11/01	5	bld	bld
			11/6/01	6	bld	bld
			5/31/02	13	bld	0.064
		6/3/02	10/18/02	2nd trt - 4	bld	0.064
Socrates Park #3	42	5/2/01	7/30/01	1st trt - 3	bld	0.93
			10/11/01	5	bld	0.13
			11/6/01	6	bld	0.35
			5/31/02	13	0.064	0.064
		6/3/02	8/30/02	2nd trt - 3	0.16	0.78
			10/18/02	4	0.1	0.29
Socrates Park #5	15.5	5/2/01	7/30/01	1st trt – 3	bld	0.28
			10/11/01	5	bld	0.15
			11/6/01	6	blq	0.17
			5/31/02	13	bld	blq[2]
		6/3/02	8/30/02	2nd trt - 3	bld	0.17
			10/18/02	4	bld	0.15
Socrates Park #6	9.5	5/2/01	7/30/01	1st trt - 3	bld	0.37
			10/11/01	5	bld	0.42
			11/6/01	6	blq	0.19
			5/31/02	13	blq	0.19
		6/3/02	8/30/02	2nd trt - 3	blq	0.26
			10/18/02	4	bld	0.15

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[2]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

ALB Program in New York 2001 – 2002
Poplar Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Socrates Park #7	13.5	5/2/01	7/30/01	1st trt - 3	0.22	1.2
			10/11/01	5	bld	0.72
			11/6/01	6	blq	0.42
			5/31/02	13	bld	0.12
		6/3/02	8/30/02	2nd trt - 3	bld	0.14
			10/18/02	4	bld	0.19
Socrates Park #8	11.25	5/2/01	7/30/01	1st trt - 3	bld	0.4
			10/11/01	5	bld	0.16
			11/6/01	6	bld	0.2
			5/31/02	13	bld	0.11
		6/3/02	8/30/02	2nd trt – 3	blq	0.3
			10/18/02	4	blq	0.2
Socrates Park #11	15	5/2/01	7/30/01	1st trt - 3	bld	0.65
			10/11/01	5	bld	0.27
			11/6/01	6	bld	0.34
			5/31/02	13	bld	0.12
		6/3/02	8/30/02	2nd trt - 3	bld	blq
			10/18/02	4	bld	blq

ALB Program in New York 2001 – 2002
Hackberry Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh”)	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Lindenhurst						
#28	22	6/5/01	8/1/01	1st trt - 2	0.12	1.3
tree treated only once			10/16/01	4	0.17	0.48
			11/12/01	5	bld	bld
			6/26/02	13	bld	bld
			9/9/02	15	bld	bld
			10/17/02	16	blq	bld
Lindenhurst						
#30	2	6/11/01	8/1/01	1st trt - 2	0.73	6.4
tree treated only once			10/16/01	4	0.25	0.44
			11/12/01	5	0.39	ns
			6/26/02	13	0.32	6.2
			9/9/02	15	bld	bld
			10/17/02	16	bld	bld
Lindenhurst						
#31	4	6/11/01	8/1/01	1st trt - 2	0.5	bld
tree treated only once			10/16/01	4	0.49	0.56
			11/12/01	5	0.65	ns
			6/26/02	13	0.16	1.8
			9/9/02	15	0.15	0.43
			10/17/02	16	bld	0.15
Lindenhurst						
#32	8	6/5/01	8/1/01	1st trt - 2	0.52	1.7
tree treated only once			10/16/01	4	bld	bld
			11/12/01	5	blq	ns
			6/26/02	13	blq	blq
			9/9/02	15	blq	0.19
			10/17/02	16	bld	bld
Lindenhurst						
#33	4	6/5/01	8/1/01	1st trt - 2	0.91	12
tree treated only once			10/16/01	4	1	3.4
			11/12/01	5	0.18	ns
			6/26/02	13	0.3	0.91
			9/9/02	15	0.56	7.4
			10/17/02	16	0.57	0.52
Lindenhurst						
#34	6	6/5/01	8/1/01	1st trt -2	0.25	2.2
tree treated only once		10/16/01	4	bld	bld	
			11/12/01	5	0.34	ns
			6/26/02	13	0.25	0.51
			9/9/02	15	bld	0.21
			10/17/02	16	blq	bld

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[2]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

[3]ns means no sample was collected; leaves had already fallen off the tree.

ALB Program in New York 2001 - 2002
Mountain Ash Trees Treated by Trunk Injection

Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Time Post-Trt (months)	Twigs (ppm)	Leaves (ppm)
Amityville						
#35	4.75	7/7/01	8/1/01	1st trt - 1	0.72	3.6
tree treated only once			10/17/01	3	0.43	0.89
			11/12/01	4	0.71	bld
			9/9/02	14	bld	0.35
			10/17/02	15	blq	0.13

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

[2]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

Persistence of Imidacloprid in Trunk-Injected Trees
Asian Longhorned Beetle Program
New York 2001 - 2002

Persistence of imidacloprid in trees treated by trunk injection in New York was examined by species. Of 51 trees treated by trunk injection, 31 were sampled throughout a year post-treatment for the presence of imidacloprid in twigs and leaves.

Norway Maple (n = 8)	twig	leaf
samples positive for residues throughout one year	6	7
avg conc of imidacloprid within 3 months post-treatment	0.23	1.30
avg conc of imidacloprid at approximately 1 year post-trt	0.13	0.30
samples positive within 3 months, negative after 1 year post-treatment	1	0
samples negative for residues	1	1

Silver Maple (n = 4*)	twig	leaf
samples positive for residues throughout one year	2	4
avg conc of imidacloprid within 3 months post-treatment	1.25	3.33
avg conc of imidacloprid at approximately 1 year post-trt	0.26	0.42
samples positive within 3 months, negative after 1 year post-treatment	1	0
samples negative for residues	1	0

*Four additional silver maple were sampled, but not through 1 year post-treatment

Sugar Maple (n = 4)	twig	leaf
samples positive for residues throughout one year	2	3
avg conc of imidacloprid within 3 months post-treatment	0.44	2.60
avg conc of imidacloprid at approximately 1 year post-trt	0.15	0.30
samples positive within 3 months, negative after 1 year post-treatment	2	1
samples negative for residues	0	0

Poplar (n = 8)	twig	leaf
samples positive for residues throughout one year	0	8
avg conc of imidacloprid within 3 months post-treatment	---	0.63
avg conc of imidacloprid at approximately 1 year post-trt	---	0.10
samples positive within 3 months, negative after 1 year post-treatment	1	0
samples negative for residues	7	0

Hackberry (n = 6)	twig	leaf
samples positive for residues throughout one year	5	5
avg conc of imidacloprid within 3 months post-treatment	0.47	2.70
avg conc of imidacloprid at approximately 1 year post-trt	0.21	1.90
samples positive within 3 months, negative after 1 year post-treatment	1	1
samples negative for residues	0	0

Mountain Ash (n = 1)	twig	leaf
samples positive for residues throughout one year	0	1
avg conc of imidacloprid within 3 months post-treatment	---	2.2
avg conc of imidacloprid at approximately 1 year post-trt	---	0.35
samples positive within 3 months, negative after 1 year post-treatment	1	0
samples negative for residues	0	0

All Trees (n = 31)	twig	leaf
samples positive for residues throughout one year	15	28
avg conc of imidacloprid within 3 months post-treatment	0.39	1.7
avg conc of imidacloprid at approximately 1 year post-trt	0.18	0.54
samples positive within 3 months, negative after 1 year post-treatment	7	2
samples negative for residues	9	1

**Residue Data from Trees Treated by Soil Injection
Chicago, 2002**

Tree Species	Tree size (DBH)	Tre e Id	Treatment Date	Sample Date	Time after Treatment	Soil Residues	Leaf Residues	Twig Residues
Maple	16	#1	4/17/03	4/5/02	Pre-trt	bld[1]	ns[2]	ns
				5/29/02	1 month	bld	ns	ns
				7/19/02	3 month	bld	0.16 ppm	bld
Maple	13	#2	4/17/02	4/5/02	Pre-trt	bld	ns	ns
				5/29/02	1 month	blq[3]	ns	ns
				7/19/02	3 month	4.4 ppm	0.58 ppm	0.1 ppm
Maple	14	#4	3/20/02	3/20/02	Pre-trt	bld	ns	ns
				4/10/02	1 month	0.83 ppm	ns	ns
				6/24/02	3 month	bld	0.2 ppm	0.1 ppm
Maple	14	#5	3/20/02	3/19/02	Pre-trt	bld	ns	ns
				4/10/02	1 month	bld	ns	ns
				6/24/02	3 month	bld	0.37 ppm	0.1 ppm
Maple	12	#6	3/20/02	3/19/02	Pre-trt	bld	ns	ns
				4/10/02	1 month	0.53 ppm	ns	ns
				6/24/02	3 month	blq	0.63 ppm	bld
Elm	28	#3	3/20/02	3/19/02	Pre-trt	bld	ns	ns
				4/10/02	1 month	bld	ns	ns
				6/24/02	3 month	bld	bld	blq
Ash	15	#7	4/17/02	4/5/02	Pre-trt	bld	ns	ns
				5/29/02	1 month	blq	ns	ns
				7/19/02	3 month	bld	bld	bld
Ash	30	#8	3/20/02	3/19/02	Pre-trt	bld	ns	ns
				4/10/02	1 month	bld	ns	ns
				6/24/02	3 month	bld	bld	bld
Ash	16	#9	4/17/02	4/5/02	Pre-trt	bld	ns	ns
				5/29/02	1 month	blq	ns	ns
				7/19/02	3 month	bld	bld	bld
Ash	17	#10	4/17/02	4/5/02	Pre-trt	bld	ns	ns
				5/29/02	1 month	blq	ns	ns
				7/19/02	3 month	bld	bld	bld

[1]bld = below the limit of detection for analyzing imidacloprid in soil, leaves and twigs; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). The sample result is negative.
[2]ns = no sample collected.
[3]blq = below the limit of quantification for analyzing imidacloprid in soil, leaves and twigs; samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

Residue Data from Trees Previously Sampled in 2000-2001
Treated by Soil Injection in 2002

Tree Species	Tree size (DBH)	Tree Id[1]	Treatment Date	Sample Date	Time after Treatment	Soil Residues	Leaf Residues	Twig Residues
Willow	5	a-WP	5/10/02	7/19/02	2 months	ns[2]	0.39 ppm	bld[3]
Willow	4	b-WP	5/10/02	7/19/02	2 months	ns	bld	bld
Willow	5	c-WP	5/10/02	7/19/02	2 months	ns	blq[4]	bld
Willow	5	d-WP	5/10/02	7/19/02	2 months	ns	1.7 ppm	bld
Box elder	11	e-WP	5/10/02	7/19/02	2 months	ns	2.2 ppm	0.3 ppm
Box elder	18	f-WP	5/10/02	7/19/02	2 months	ns	0.53 ppm	blq
Box elder	11	g-WP	5/10/02	7/19/02	2 months	ns	blq	bld
Box elder	10	h-WP	5/10/02	7/19/02	2 months	ns	0.45 ppm	blq

[1]WP = trees sampled in Winnimac Park; identified by codes linked to GPS coordinates.
[2]ns = no sample collected.
[3]bld = below the limit of detection for analyzing imidacloprid in soil, leaves and twigs; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). The sample result is negative.
[4]blq = below the limit of quantification for analyzing imidacloprid in soil, leaves and twigs; samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

Imidacloprid Residues in Tree Blossoms
ALB Program in New York 2001-2002

Tree Species	Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Results (ppm)
norway maple	Amity 16	26.5	7/5/01	4/16/02	bld[1]
norway maple	Amity 22	21.5	7/2/01	4/16/02	bld
norway maple	Amity 23	19	7/2/01	4/16/02	bld
norway maple	Amity 24	23.25	7/2/01	4/16/02	bld
norway maple	Amity 25	26.25	7/2/01	4/16/02	0.13 ppm
norway maple	Amity 27	12.5	7/5/01	4/16/02	bld
silver maple	SS 9	13.5	5/2/01	4/12/02	bld
silver maple	SS 10	8	5/2/01	4/12/02	bld
silver maple	Amity 19	25.75	7/3/01	3/28/02	bld
silver maple	Amity 20	28	7/3/01	3/28/02	bld
silver maple	Linde 29	26	6/5/01	3/28/02	blq[2]
sugar maple	Amity 14	23	7/3/01	4/16/02	bld
horse chestnut	Massa 1	12.5	5/31/01	4/29/02	bld
horse chestnut	Massa 2	17	5/31/01	4/29/02	blq
horse chestnut	Massa 3	23.25	6/2/01	4/29/02	bld
horse chestnut	Massa 4	24	6/4/01	5/6/02	blq
horse chestnut	Amity 5	14	6/30/01	5/6/02	blq
horse chestnut	Amity 6	12	7/5/01	5/6/02	bld
horse chestnut	Linde 7	14	6/5/01	5/6/02	bld
horse chestnut	Islip 8	20	6/6/01	5/15/02	bld

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). The sample result is negative.

[2]blq means samples cannot be reliably quantified, however imidacloprid was present in the sample in a concentration between 0.030 and 0.099 ppm.

Imidacloprid Residues in Tree Blossoms
ALB Program in New York 2002-2003

Tree Species	Tree Id	Tree Size (dbh")	Treatment Date	Sample Date	Results (ppm)
norway maple	Amity 16	26.5	6/14/02	4/30/03	bld[1]
norway maple	Amity 22	21.5	not enough blossoms		
norway maple	Amity 23	19	not enough blossoms		
norway maple	Amity 24	23.25	not enough blossoms		
norway maple	Amity 25	26.25	not enough blossoms		
norway maple	Amity 27	12.5	6/14/02	4/21/03	bld
silver maple	SS 9	13.5	6/3/02	4/23/03	bld
silver maple	SS 10	8	6/3/02	4/23/03	bld
silver maple	Amity 19	25.75	not enough blossoms		
silver maple	Amity 20	28	not enough blossoms		
silver maple	Linde 29	26	not enough blossoms		
sugar maple	Amity 14	23	not enough blossoms		
horse chestnut	Massa 1	12.5	5/25/02	5/12/03	bld
horse chestnut	Massa 2	17	5/25/02	5/12/03	blq
horse chestnut	Massa 3	23.25	6/1/02	5/15/03	bld
horse chestnut	Massa 4	24	5/31/02	5/15/03	bld
horse chestnut	Amity 5	14	6/18/02	5/15/03	bld
horse chestnut	Amity 6	12	6/13/02	5/15/03	bld
horse chestnut	Linde 7	14	7/11/02	5/15/03	bld
horse chestnut	Islip 8	20	no trt in '02	5/15/03	bld

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). The sample result is negative.

ALB Program in NY 2001- 2003
Corona Park Zoo Duck Pond

Site Id	Trt Date of Trees Near Pond	Sample Date	Time Post-Trt (months)	Water (ppm)
Duck Pond	5/7/01	11/7/01	6	bld
Duck Pond	5/24/02	6/11/02	1	bld
Duck Pond	5/24/02	3/14/03	10	bld

[1]bld means below the limit of detection for the analytical method; imidacloprid cannot be detected in a concentration less than 0.030 parts per million (ppm). In other words, the sample result is negative.

APPENDIX B

EXPOSURE SCENARIOS

Explanation of Terms

Human Health and Safety

The Environmental Protection Agency (EPA) has developed reference levels for registered pesticides to provide margins of safety for the general public (USEPA, 1998a, USEPA, 1998b; USEPA, 1999; USEPA, 2001). From toxicity studies submitted as part of the registration process for imidacloprid, the EPA has established a No Observable Adverse Effect Level (NOAEL) for imidacloprid of 42 mg/kg body weight/day, where a one time feeding at this concentration resulted in no ill effects in laboratory mammals. From this toxicological end point a safe exposure level is determined known as a reference dose (RfD). The RfD is calculated by dividing a NOAEL by 100 (100 is used as a safety factor because studies were done on animals and not humans, and because there could be differences in susceptibility among different age groups). Thus, the RfD for imidacloprid would be 0.42 mg/kg body weight/day. EPA has recently added another child safety factor (3X) as part of the Food Quality Protection Act (FQPA). Taking into account this safety factor, the safe exposure level or RfD for acute toxicity (or a one time exposure) is 0.14 mg/kg/day.

For each of the following scenarios, the estimated exposure was divided by the EPA reference dose with the FQPA safety factor included (0.14mg/kg/day) to give a hazard quotient (HQ) for each situation. Hazard quotients of less than one, show that the estimated dose did not exceed the reference dose and so little risk is expected. The further the HQ is below 1.0, the lower the risk. Hazard quotients greater than 1.0 occur when the estimated exposure exceeds the RfD. Risk increases as the HQ increases.

Conservative assumptions about the amount of exposure, the opportunity for exposure, availability of ingested or absorbed doses and the frequency of exposure were made for each scenario. By design, each scenario overestimates the most probable level of exposure and risk to assure an extra margin of safety.

Ecological Effects

The EPA has established acute toxic dose levels for several species to assist in determining potential ecological effects from pesticides or other chemicals. These levels are known as LD_{50} levels or doses that have a 50% chance of causing mortality in a population exposed to that dose for a defined period of time. To estimate a dose that will not have lethal effects, a safe dose is considered 10 times less than the LD_{50} for species that are not threatened or endangered.

Toxicological information available for some common species following exposure to a given dose of imidacloprid includes:

Acute oral route (one time ingestion)

House sparrow = LD_{50} 41.7 mg/kg body weight (USEPA, 1994)

Earthworms = LD_{50} of 2.3 – 10.7 mg/ kg soil (Luo, Y. et. al, 1991)

Squirrel = LD_{50} of 45 mg/kg body weight (USEPA, 1993)

Honey bee = LD_{50} of 4000 to 41,000 µg/bee - this translates to a concentration in nectar or pollen of between 0.14 and 1.6 mg/kg (Schmuck, R. et. al. 2001)

Acute dermal route (exposure is for 48 to 96 hours)

Rainbow trout = LC_{50} (imidacloprid in water) of 211 mg/l (USEPA, 1994)

Freshwater shrimp = LC_{50} of 37 µg/l (USEPA, 1994)

Daphnia (water flea) = LC_{50} of 10.4 to 85.0 mg/l (USEPA, 1994)

An LC_{50} is the concentration of a toxicant in water that has a 50% chance of causing mortality in a population exposed to that dose for a defined period of time. To estimate a dose that will not have lethal effects, a safe dose is considered 10 times less than the LC_{50} for species that are not threatened or endangered.

Scenario: A small child weighing 15 kg (33 lbs) exhibits pica (a behavior involving ingestion of unusually high amounts of soil) and consumes 10 grams of soil following soil injection with imidacloprid.

Assumptions:

C_{soil} = concentration of contaminant in soil (mg/kg) x (10^{-3}g/mg)

[Soil contains 4.4 mg of imidacloprid/kg soil (or 0.0044 mg/gram of soil) - the highest concentration of imidacloprid recovered in treated soil from environmental monitoring data.]

SI = amount of soil ingested during a one time pica episode

[A child ingests 10 grams of soil (USEPA, 2000). This value is considered high but not unreasonable; a more typical amount of soil consumed by a child with pica is 200 mg)

A 15 kg toddler represents children in the 1 to 6 year old age group; young children are considered a sensitive subpopulation of the general public

The RfD for acute exposure with a 3x FQPA safety factor is 0.14 mg/kg/day

Calculations:

Estimated dose = C_{soil} X SI ÷ weight of child

$$= 10 \text{ gms of soil} \times \frac{0.0044 \text{ mg imidacloprid}}{\text{gm soil}} \div 15 \text{ kg}$$

= 0.0029 mg/kg

Hazard Quotient = estimated dose ÷ RfD

= 0.0029 mg/kg ÷ 0.14 mg/kg

= 0.02 HQ

Conclusion:

The estimated dose is 50 times lower than the RfD. Little risk would be expected were a small child to eat 10 gms of treated soil containing 4.4 mg/kg imidacloprid. Even with the above conservative estimates, children (or adults) would not be exposed to harmful levels of imidacloprid through incidental ingestion of treated soil.

Scenario: A small child weighing 15 kg (33 lbs) is playing in the dirt under a tree that was treated with imidacloprid by soil injection.

Assumptions:

To estimate a dermally absorbed dose (USEPA, 1992), imidacloprid in the soil must desorb from the soil and come in contact with the skin surface where it is absorbed through the skin primarily by diffusion. The absorbed dose for a one time acute exposure is based on the amount of chemical in soil, the adherence factor of soil to skin, and the absorption fraction (percent absorbed).

A 15 kg toddler represents children in the 1 to 6 year old age group; young children are considered a sensitive subpopulation of the general public

From USEPA Exposure Factors Handbook (1999):

C_{soil} = concentration of contaminant in soil (mg/kg) x (10^{-6} kg/mg)

[Assume soil contains 4.4 mg of imidacloprid/kg soil (or 4.4 x 10^{-6} mg/mg of soil) - the highest concentration of imidacloprid recovered in treated soil from environmental monitoring data. It is assumed all of the chemical in the soil is not bound to any soil particles and is available for transfer from soil to skin. It is also assumed no chemical has degraded.]

SSA = skin surface area available for contact (cm^2)

[The mean skin surface area of both hands of a toddler (3 years old) available for contact with soil is 20 cm^2]

AF = adherence factor or amount of soil adhering to unit area of skin (mg/cm^2)

[The amount of soil adhering to children's hands ranges from 11mg to 159 mg based on results from different studies; for this scenario the most conservative estimate of soil adhering per unit area of skin is 0.9 mg/cm^2 (Roels et al, 1980)]

Different chemicals are absorbed through the skin at different rates. For simplicity, it is assumed that 100% of imidacloprid will be absorbed in the time period a child would use to play in soil (20 minutes to 2 hours).

Calculations:

$$\text{Estimated Dose} = \frac{C_{soil} \text{ x AF x SSA}}{\text{weight of child}}$$

$$= \frac{4.4 \text{ x } 10^{-6} \text{ mg imidacloprid}}{\text{mg soil}} \text{ X } \frac{0.9 \text{ mg soil}}{\text{cm}^2} \text{ X } 20 \text{ cm}^2 \div 15 \text{ kg}$$

$$= 5.3 \text{ x } 10^{-6} \text{ mg/kg}$$

The RfD for acute exposure with a 3x FQPA safety factor is 0.14 mg/kg/day

Hazard Quotient = estimated dose ÷ RfD

$$= 5.3 \times 10^{-6} \text{ mg/kg} \div 0.14 \text{ mg/kg/day}$$

$$= 3.8 \times 10^{-5}$$

Conclusion:

The HQ is almost five orders of magnitude below 1; the estimated dose is more than 25,000 times lower than the RfD. Little or no risk would be expected were a small child to play in treated soil containing 4.4 mg/kg imidicloprid even if combined with pica behavior. Using the above conservative estimates, children (or adults) would not be exposed to harmful levels of imidacloprid through incidental contact with treated soil.

Scenario: A small child weighing 15 kg (33 lbs) eats leaves from a tree that was treated with imidacloprid by trunk injection.

Assumptions:

C_{leaves} = concentration of chemical in leaves (mg imidacloprid/kg leaves)
[The average concentration of imidacloprid in leaves from environmental monitoring was 1.4mg/kg. It is assumed no degradation of chemical has occurred in the leaves.]

LI = amount of leaves ingested during a one time event (kg)
[Average intake of fruits and vegetables in a day for a child 3-5 years old, weighing 15 kg is approximately 250 gms (USEPA, 2000) or 0.25 kg. Assume a child would eat this same weight in leaves and that all imidacloprid in leaves in absorbed through the gut.]

Calculations:

Estimated dose $= C_{leaves} \text{ X } LI \div \text{weight of child}$

$= 1.4 \text{ mg/kg X } 0.25 \text{ kg} \div 15 \text{ kg}$

$= 0.023 \text{ mg/kg}$

Hazard Quotient $= \text{estimated dose} \div \text{RfD}$

$= 0.023 \text{ mg/kg} \div 0.14 \text{ mg/kg/day}$

$= 0.16$

Conclusion:

The HQ is below 1; the estimated dose is more than 5 times lower than the RfD. Little risk would be expected were a small child to consume 250 gms (almost 0.5 lbs) of leaves containing 1.4 mg/kg imidacloprid. Even with the above conservative estimates, children (or adults) would not be exposed to harmful levels of imidacloprid through incidental ingestion of treated leaves.

To put it another way, if a child were to eat leaves containing the highest amount of imidacloprid detected in this monitoring effort (40 mg/kg) she would have to ingest 53 moderately sized leaves (e.g. a maple leaf weighs approximately 1 gm) to reach the RfD of 1.4mg/kg/day.

Scenario: A small child weighing 15 kg (33 lbs) plays in dried leaves from a tree that was treated with imidacloprid by trunk injection.

Assumptions:

Imidacloprid is confined to plant tissue so no chemical would be available on the leaf surface for contact with exposed skin. No dermal exposure would be expected.

Some exposure through inhalation of "leaf dust" might occur.

C_{leaves} = concentration of chemical in leaves (mg imidacloprid/kg leaves)
[The highest concentration of imidacloprid in leaves collected in autumn from 2000 – 2001 environmental monitoring was 5mg/kg.]

Only dust particles in the range of 10 to 100 microns in size are respirable (for comparison, a human hair is 25 to 50 microns in diameter).

$LM_{respirable}$ = leaf mass in the form of dust particles small enough to be respirable [Pile of leaves weighs 5 kg (11 lbs), assume as much as 1% (.05 kg) of leaf mass could be in the form of dust small enough to be respirable]

V = volume of air child breathes while playing in leaves
[The leaf dust cloud encompasses a 100 m^3 air space (approximately 5' x 5' x 5')]

The child is breathing in that air space only.

$$\text{Estimated dose} = C_{leaves} \div LM_{respirable} \div V$$

$$= 5\ \text{mg/kg} \div 0.05\ \text{kg} \div 100\ \text{m}^3$$

$$= 1\ \text{mg/m}^3$$

Conclusion:

The USEPA has established a level of exposure that is known as the no observed effect level (NOEL). This level has been established following testing in rats and is 5060 mg of imidacloprid /m^3 of air. The NOEL means that imidacloprid levels up to 5060 mg/m^3 in air have been shown to not cause any adverse health effects in test animals. The EPA uses a safety factor of 10 when extrapolating data from test animals to humans, and another safety factor of 10 to take into account the sub-populations of individuals that might be unusually sensitive to chemical exposures, such as children. Taking these considerations into account, the NOEL for sensitive individuals would be 50.6 mg imidacloprid in a m^3 of air. The amount of imidacloprid that might be in respirable leaf dust particles has been estimated at 1.0 mg/m^3. This concentration is 50 times less than the NOEL, even for sensitive individuals such as children. Thus, inhalation exposure of children to imidacloprid in leaf dust particles is minimal and the health risk is negligible.

Scenario: A house sparrow, considered to be one of the most sensitive of the bird species to imidacloprid, eats insects that have eaten leaves from a treated tree.

Assumptions:

$C_{insects}$ = concentration of chemical present in insects (mg/kg)
[Assume the concentration of imidacloprid in insects is the same as the average concentration found in leaves (1.2 mg/kg)

DI = daily intake of food (kg insects/adult sparrow/day)
[Average house sparrow diet over a year consists of 1.1 kg seeds, 2.37 kg cereal grains and 0.55 kg insects per adult sparrow. (Gough, G.A. *et. al.*, 1998). Over 365 days the daily intake of insects could be a much as 0.0015 kg insects/adult/day (0.55 kg ÷ 365 days)]

Wt = average weight of adult house sparrow weighs (kg)
[Assume an adult sparrow weighs approximately 0.024 kg. (Gough, G.A. *et. al.*, 1998)]

LD_{50} = 41.7 mg/kg

Estimated safe dose = LD_{50} ÷ 10 = 4.17 mg/kg

Calculations:

Estimated acute dose = $C_{insects}$ X DI ÷ Wt

= 1.2 mg/kg X 0.0015 kg ÷ 0.024 kg

= 0.075 mg/kg

Estimated safe dose = 4.17 mg/kg

Conclusion:

The amount of imidacloprid ingested (0.075 mg/kg) is 55 times less than what would be considered a safe dose, so no adverse effects would be expected were an adult house sparrow to eat only insects contaminated with a concentration of 1.2 mg/kg imidacloprid. Insects are not a part of juvenile and fledging sparrows' diets so there is no concern for exposure through ingestion of insects for the young sparrows.

Scenario: A gray squirrel eats nuts from a treated tree; sole diet comprises nuts containing imidacloprid.

Assumptions:

C_{nuts} = concentration of chemical present in nuts (mg/kg)
[Assume the concentration of imidacloprid in nuts is the same as the average concentration found in leaves (1.2 mg/kg). A nut weighs approximately 1 gm, amount of imidacloprid in one nut is 0.00012 mg/gm (1.2 mg ÷ 1000 gms)]

DI = daily intake of food (kg /adult squirrel/day)
[Squirrel eats 20 grams of food each day (Halloran, P. 2001); assume diet comprises only nuts containing imidacloprid, although typically squirrels eat seeds, flowers, buds and fruits as well.]

Wt = average weight of squirrel (kg)
[Squirrel weights range from 300 to 700 gms. Assume squirrel weighs approximately 500 grams or 0.5 kg (Halloran, P., 2000)

LD_{50} = 45 mg/kg

Estimated safe dose = $LD_{50} \div 10$ = 4.5 mg/kg

Calculations:

Estimated acute dose = C_{nuts} X DI ÷ Wt

= 0.00012 mg/gm X 20 gms ÷ 0.5 kg

= 0.0048 mg/kg

Estimated safe dose = 4.5 mg/kg

Conclusion:

The amount of imidacloprid ingested (0.0048 mg/kg) is 937 times less than what would be considered a safe dose, so no adverse effects would be expected were an adult gray squirrel to consume only nuts contaminated with imidacloprid in a concentration of 1.2 mg/kg. Squirrels are generalist feeders. They may feed on as many as 97 plant (nuts, flowers, buds, fruits and seeds) and 14 animal items (bones, bird eggs, frogs), so it is unlikely that squirrels would only eat material from treated trees.

Scenario: Honey bees pollinate maples and horsechestnut trees; two host species that have been treated with imidacloprid.

Assumptions:

C_{pollen} = Concentration of imidacloprid in pollen
[Residue data from maple and horsechestnut blossoms indicates that only 1 of 32 samples contained imidacloprid that could be quantified (0.13 mg/kg blossoms). Assume the amount of imidaclprid in blossoms represents the amount in pollen that could be available to bees.]

LD_{50} for honey bees = dose of imidacloprid that could be fatal to half of a population exposed to that dose
[LD_{50} for honey bees is 4,000 to 41,000 µg/bee - this translates to a concentration in nectar or pollen of between 0.14 and 1.6 mg/kg (Schmuck, R. et. al. 2001)]

Conclusion:

If honey bees gather pollen exclusively from blossoms of treated trees containing residues of 0.13 mg/kg, some bee mortality could occur since this concentration approaches the lower range of the LD_{50} for honey bees.

2006 Environmental Monitoring Report Asian Longhorned Beetle Cooperative Eradication Program

for the active eradication region in:
Suffolk County, New York

Prepared by:
USDA/APHIS/PPQ
Emergency and Domestic Programs
Environmental Compliance

May 2007

United States Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine

Background

Environmental monitoring to test for residues of imidacloprid, as part of the Asian Longhorned Beetle (ALB) Cooperative Eradication Program, has been conducted on Long Island since 2002. Imidacloprid is a systemic insecticide used as a preventative treatment of noninfested ALB host trees at risk for infestation. Groundwater monitoring in Suffolk County has been conducted since 2003 and began as part of a special use exemption to a local law requiring the phase out of pesticide use in Suffolk County. The exemption allowed for the prophylactic treatment of host trees on municipal property in the County.

Initially four groundwater well sites were chosen for sampling in May and June of 2003 near trees on County property that had been treated with imidacloprid by trunk injection in 2001 and 2002. Trees were subsequently treated in 2003. The treated trees were part of wood lots within residential areas. In late September 2003, two additional wells were placed in the same vicinity but were not down-gradient of treated trees and served as negative controls. In October 2003, three additional wells were installed on Indian Island, where approximately 4000 trees were treated with imidacloprid by trunk injection in 2001 and 2002. The Indian Island site was chosen because the groundwater could be isolated from the rest of Long Island. If imidacloprid was found in groundwater on Indian Island the source was most likely from trunk injected trees.

In 2004, the Environmental Quality staff of the Suffolk County Department of Health Services (SCDHS) continued groundwater monitoring. USDA did not participate in this work. Two new wells were installed and sampled in the Copiague/Amityville area in 2004. In early 2005, six wells were also installed and sampled in Lindenhurst. In March 2005, as part of an annual request for the special use exemption granted by the SCDHS Community Advisory Committee, USDA was asked to participate again in the groundwater monitoring effort. Monitoring was expanded to include two more wells which were installed at Bergen Point Golf Course. During 2006, APHIS continued to sample groundwater monitoring wells located near program sites in Suffolk County, NY for the presence of imidacloprid.

This report details the results of the 2006 monitoring effort, presents all monitoring results since 2003, and examines if there are any trends in the monitoring data related to the treatments conducted by the ALB Program. The monitoring conducted in 2006 was part of an effort by APHIS and SCDHS to determine if ALB Program systemic treatments of host trees could result in the movement of imidacloprid from treated trees into groundwater on Long Island. Groundwater from monitoring wells was collected, along with soil samples from around each well head and leaf litter from treated trees in close proximity to the wells, to address this objective.

2006 Monitoring Effort

There are currently 16 active monitoring wells in the Islip and Lindenhurst areas, which include 2 control wells. Wells located on Indian Island in Great South Bay were part of the monitoring plan, but are no longer sampled due to saltwater intrusion. In 2006, all 16 active wells were sampled. Sampling took place on January 10 and 11, April 4 and 5, July 11 and 12, and October 25 and 26. When possible, samplers also collected soil samples at 1-inch and 6-inch depths and leaf litter samples, when available. Multiple samples were taken at some sites based on availability. Soil is generally not collected from private property. The soil and leaves assist in determining possible sources of imidacloprid.

All samples were sent to the PPQ Analytical and National Products Chemistry Laboratory (ANPCL) in Gulfport, MS for analysis. Water samples were split and shared with the Suffolk County Department of Health, which also analyzed the water for imidacloprid and other chemicals (results of which are not presented here).

ANPCL analyzed 44 leaf litter samples (3 additional leaf litter samples were too small in mass for analysis), 30 one-inch deep soil samples, 31 six-inch deep soil samples, and 64 groundwater samples. (Tables 1-20, which also include treatment and sample information prior to 2006.) In summary:

- Of the 44 leaf litter samples, 14 (32%) did not contain imidacloprid, 11 (25%) contained trace levels, and 19 (43%) had quantifiable levels of imidacloprid (mean: 0.77 ppb; range 0.13-2.8 ppb).

- Of the 30 one-inch deep soil samples, 27 samples did not contain imidacloprid (<0.03 ppb), 2 (wells #4 and 20) had only trace levels too low to accurately quantify (0.03-0.1 ppb), and 1 well (#16) contained 0.35 ppm imidacloprid.

- Of the 31 six-inch deep soil samples, 30 samples did not contain imidacloprid (<0.03 ppb) and the other 1 (well #13) had only trace levels too low to accurately quantify (0.03-0.1 ppb).

- Of the 64 groundwater samples, 30 (47%) had no detectable imidacloprid (limit of detection: 0.060 to 0.075 ppb); 8 (12%) had trace levels of imidacloprid (0.06-0.20 ppb); and 26 (41%) samples had quantifiable levels of imidacloprid. (Note that ppb = µg/l, as reported in the tables.) These 26 samples had concentrations of the pesticide ranges from 0.21-17 ppb, with a mean concentration of 3.2 ppb. The control wells (#5 and #6) had no detectable levels of imidacloprid.

The New York State "Imidacloprid Groundwater Monitoring Project Plan," signed by representatives from Bayer CropScience and the NYS Department of Environmental Conservation, established an "action threshold" of 25 ppb (half of the New York State drinking water standard) for imidacloprid. Bayer CropScience has told APHIS that if multiple groundwater detections occurred at or above 10 ppb, mitigation steps would be taken. These "action thresholds" were intended for groundwater samples taken from the monitoring wells established for the NYS imidacloprid groundwater monitoring project. The 16 wells discussed here are part of the monitoring project and no samples were above the 25 ppb threshold, indicating no risk to human health. Well #1 had a single detection above 10 ppb (11 ppb on January 10) and Well #16 had two detections above 10 ppb (17 ppb on January 11 and 11 ppb on April 5). Levels have since decreased to below 10 ppb and no mitigation was required at the sites.

Trends in Monitoring Data, 2003-2006

The summary of the samples taken in 2006 provides no information on trends in the chemical residues, and previous annual monitoring reports have had too little data to make trend investigations worthwhile. Monitoring and treatment information through time for each well is provided in Tables 1-20 and some of the real and apparent patterns in the longer-term data are presented below.

Question #1 – What is the relationship between ALB treatment data and imidacloprid residue in groundwater?

If ALB treatments were resulting in increased imidacloprid residues in groundwater, one would expect some relationship where imidacloprid residues are higher sometime after treatment and decrease over time. Figure 1, showing imidacloprid concentrations in groundwater against days since the last treatment would initially appear to show such a pattern. But the ten data points greater than 5 ug/l are distracting from the rest of the 118 data points. Only 2% of the variation ($r^2 = 0.0198$) in the data is explained by the relationship between imidacloprid and days since the last treatment, with a weak negative slope to the regression equation. (If one factors out the negative detections, the variance explained by the relationship increases to only 4%, again with a weak negative slope.)

At least amongst the highest residue points in Figure 1, there would appear to be a clear inverse relationship between imidacloprid and days since the last treatment. But this apparent relationship is the result of data generated from only two of the wells monitored since 2003, #1 and #16. When they are removed from the data, the relationship becomes even weaker, both in terms of the slope of the equation and the variation explained by the relationship ($y = -0.0006x + 0.9581$, $r^2 = 0.0106$).

Question #2 – What patterns exist near Well #1?

Since Well #1 was one of two wells with unusually high residues of imidacloprid, residue patterns through time are investigated at the site as well as at other sites in the vicinity. If the ALB treatments were resulting in the higher residues in Well #1, it is expected that there would be some relationship between treatment date and increasing residue levels. One would expect the residues levels to increase after the treatment (although there might possibly be a lag between treatment date and highest residues levels), with residues decreasing through time until and next treatment.

Such a pattern was not observed at Well #1 (Figure 2). For example, there was a weak increase in imidacloprid residues following a treatment in July 2003 while there was a sharp increase in residues following a treatment in June of 2004. However, there was then a steep decline in residues in 2005 followed by another sharp increase in 2006 although there was no corresponding treatment. In fact, the odd increase in imidacloprid residues in early 2006 without a corresponding treatment was observed in Well #2 (Figure 2), less than 100 feet away from Well #1. While this odd spike in 2006 correlated with that in Well #1, Well #2 showed a decrease in imidacloprid residues after the June 2004 treatment, unlike the 2005 spike observed in Well #1.

In addition, the patterns through time at Wells #3 and #4 (Figure 3) do not correspond to the patterns observed at either Wells #1 or #2, even though they are located close to each other (Figure 4) and were treated at very similar times (Figure 5, Tables 1-4). Wells #3 and #4 were lower in overall imidacloprid residues. Wells #3 and #4 show rises and falls in imidacloprid residues that have little, if any, relationship with the treatment date. For example, Wells #3 and #4 show a decrease in residues in June 2005 followed by an increase in October 2005 and

January 2006 without any additional treatment after June 2005. (Whether or not there is some potential seasonal effect is discussed below in Question #5.) In the end, wells very close to each other with very similar treatments do not track each other in residues nor do they appear to show any strong relationship with residues and the time since the last treatment.

Question #3 – What patterns exist near Well #16?

Well 16 was the subject of an investigation by APHIS and Bayer CropScience in 2005 after samples collected and analyzed by the Suffolk County Department of Health Services (SCDHS) in May and June 2005 revealed concentrations of imidacloprid above 200 ppb. Samples collected by APHIS and SCDHS and analyzed by both labs noted high concentrations of imidacloprid. ANPCL reported the highest concentration as 22.1 ppb in June 2005. Since that time, the concentration of imidacloprid in Well #16 has decreased to levels consistent with other monitoring wells (Table 16, Figure 6). In 2006, no groundwater monitoring well had concentrations of imidacloprid that exceeded the NYS action threshold of 25 ppb.

As with Wells #1-#4, Well #16 does not show residue patterns through time that are similar to other nearby wells with similar treatment histories. Well #16 appears to show a high residue value that decreases through time following a treatment made on May 11, 2005. But this same pattern was not observed in Wells #15 & #17 (Figure 6), even though the wells are all within 32 feet of each other (Figure 9). Other nearby wells, #14 and #18-#20, also fail to show similar residue patterns through time (Figures 7 & 8). Wells #14 and #18 even show an increase in residue values after several months of low residues, although the most recent treatment was over 300 days prior to the increase. Without any trends through time between nearby wells with similar treatments, it is difficult to suggest that the ALB treatments are the cause of any of the residue values.

Question #4 – Is there an explanation for the relatively high residues at Well #16?

In November 2005, the New York State Department of Environmental Conservation (DEC) provided APHIS with test results from groundwater monitoring conducted by SCDHS on Long Island. Of note, the Suffolk County Public and Environmental Health Laboratory recovered imidacloprid at a concentration of 200 ppb from Well #16 (or SCDHS well L2-54) in Lindenhurst that was installed on April 6, 2005 and sampled on April 13. DEC expressed concern that this unexpectedly high concentration was possibly associated with the ALB Program. An additional sample taken by SCDHS on May 17 was reported to have 205 ppb imidacloprid. Samples taken on April 13 and May 17, 2005 by SCDHS were not split and shared with APHIS, and no APHIS residue value is reported in Table 16.

There is one tree, a 24-inch DBH sycamore (Platanus) in close proximity to Well #16 (Figure 9). It was treated by trunk injection using Mauget capsules on 7/13/2002 (48 ml) and using an ArborJet injector on 8/2/2004 (192 ml) and 5/11/2005 (48 ml). Fourteen trees up-gradient and in close proximity of this well were also treated in 2004 and 2005 by ArborJet. Two additional wells (#15 and #17) within 25 feet of well #16 were installed in early May, 2005 (Figure 9). These wells are down gradient of the same fourteen treated trees treated in 2004 and 2005.

Groundwater samples collected from Wells #15 and #17 are consistent with results obtained at other wells in close proximity to trees treated with imidacloprid by the ALB

Program. For example, results for samples taken from Well #4, which was placed in a wood lot and surrounded by 2500-3500 trees treated by trunk injection, ranged from negative to 3.9 ppb (Table 4, Figure 3). Additionally, samples from 3 wells placed on Indian Island (each well sampled twice) down gradient of 3200-4500 trees treated by trunk injection were all negative for imidacloprid residues (Tables 7-10).

Well #16 and the sycamore tree are located at the edge of the front lawn and adjacent to a paved driveway in a suburban community on the south shore of Long Island. Homes in the neighborhood are small, tightly packed single-family dwellings, all with lawns. ALB-PPQ-NY reports that during their investigation and sampling, the lawns appeared well maintained and that given the sandy soil present, probably were actively managed. NYS DEC and SCDHS investigated the site, including speaking with home owners on the street about their use of imidacloprid containing pesticides such as Grubb-X. All interviewed homeowners reportedly deny use of these products.

The high residues recovered by SCDHS from Well #16 in 2005 are significantly higher than residues found in any other well associated with an ALB Program-treated tree (Tables 1-20). ALB Program application records and onsite observation of the August 2004 injection revealed no spills or other unusual events. The concentrations of imidacloprid in Well #16 have since declined to levels in line with other wells on Long Island. Based on several years of environmental monitoring data, it seems highly unlikely that residues found in Well #16 in the spring of 2005 can be attributed to trunk injections. Unfortunately, the USDA was not informed of the April and May SCDHS results until November 2005, seven months after the first sample was taken, so any meaningful investigation could not be conducted. Chemical treatment is one component of the integrated strategy for eradicating the ALB from the United States. Once treatments begin in an area, only a few years of consecutive annual applications are required to eliminate ALB populations. The finding of 200+ ppb imidacloprid in Well #16 is likely the result of one-time event well outside the standard operating procedures of the ALB Program. Although the well is located near an ALB Program treated tree, the source of the imidacloprid may not be the ALB Program.

Question #5 – Does the time of year influence imidacloprid values?

Some of the figures in this report suggest possible patterns in imidacloprid residues that may be seasonal in nature, perhaps related to the activity of the trees producing and later dropping leaves. Figure 10 shows the residue data from all wells plotted through time. There are no clear peaks or troughs in the data showing any effect of time of year. Although Figure 10 indicates the approximate treatment dates, not all of the wells were near trees having similar treatment schedules. For example, in 2005, only Wells #12-#20 had nearby trees with treatments but sampling was conducted at all wells.

Figure 11 presents the same data as in Figure 10, but collapsed by year, in order to remove any artifacts due to the different treatment regimes. Treatments were conducted between late April and early July on any given year. Apparent residue peaks seem to occur around January, April, and July with intervening low residues around March, May, and October. Although these peaks and valleys in the data seem real, there is no biological reason to suggest that the residues were due to ALB Program treatments. For example, in the spring, both high residues (April) and low residues (March, May) were observed, even though the same biological patterns are occurring in the tree, namely growth and the addition of biomass as the tree buds and produces leaves. The number of relatively high residue values (10 samples > 5 ppb) differ from those samples low in residue (110 samples < 5 ppb), meaning that Figure 11 visually places an emphasis on the high values that are few in number. Whether or not these high values are due to some seasonal effect or are some statistical artifact in the data cannot be determined at this time. It should also be noted that the sampling protocol for environmental monitoring was not designed to investigate annual trends and that residue samples were not collected in February, August, and September. While there is a possibly of an effect of season on imidacloprid residues, it is unclear if ALB Program treatments are part of this pattern.

Question #6 – What is the risk to human health from these residues?

Exposure to the chemical does not mean that health effects will occur. For example, imidacloprid is permitted on food products at levels ranging from 0.05-15.0 ppm on various food commodities (40 CFR § 180.472). The risk of health effects from exposure to a chemical can be calculated by comparing the potential dose (the amount of pesticide that gets into the body) with the reference dose. The reference dose (RfD) is considered a safe level of exposure, based on scientific studies that establish the lowest dose needed to have an observable adverse effect with additional safety factors built in to account for potentially sensitive individuals such as children. The EPA has determined the acute RfD (for immediate effects) for imidacloprid to be 0.42 mg/kg body weight/day and the chronic RfD (for long-term effects) to be 0.057 mg/kg body weight/day.

For one to obtain a dose of imidacloprid from groundwater, the only route of exposure is ingestion. In this risk calculation, a 2-year-old male is considered, as small children tend to be more susceptible to the effects of chemicals. According to the EPA, the average body weight of a 2-year-old male is 13.6 kg. For this child to be exposed to levels of imidacloprid that might have the potential to cause adverse effects, he would have to consume more than 0.78 mg imidacloprid per day (13.6 kg child * 0.057 mg/kg/day = 0.7752 mg imidacloprid/day). To ingest this amount of imidacloprid, the child would have to consume 1.0 gallon of groundwater on a daily basis at the highest reported residue of 205 ppb (= 205 µg imidacloprid/liter water) reported by the SCDHS [(0.78 mg imidacloprid/day)*(1000 µg/mg)*(liter/205 µg imidacloprid) = 3.8 liters = 1.0 gallon of groundwater]. This means that to have the possibility of a chronic effect, the child would have to consume 1.0 gallon of the highest residue groundwater every day, which is an extremely unlikely event. Doing the same calculation above using the acute RfD, the child would have to consume over 7 gallons of the highest residue groundwater in a single day for there to be the possibility of a short-term health effect.

All of the estimates above are conservative, in an attempt to maximize the likely reasonable parameters involved in the calculations. It is likely that the true health risk would be even less than estimated above, especially as the highest USDA-confirmed residue was almost 10x lower than that reported by SCDHS and that only the highest single residue value was used in the calculations rather than some average value. Risks to adults are even less than that for children due to their larger body weight, which requires a higher dose of imidacloprid to have an adverse effect.

Conclusions

Environmental monitoring conducted for the ALB Program was designed to determine if imidacloprid could be entering the environment from program treatments and to confirm that any residues in the environment are below levels that might cause significant human health or environmental effects. The monitoring data from 2003-2006 suggests that there might be a possibility that program treatments are resulting in detectable residues in the environment. However, since imidacloprid was allowed for private and commercial use during the ALB treatment period, it is impossible to determine the source of the residues. Furthermore, there is no pre-ALB treatment data to indicate whether or not imidacloprid was present in the environment at some background level, making it difficult to assign residues solely to the ALB Program. While it is possible to track program-applied imidacloprid, it would be prohibitively expensive to do so. Even though imidacloprid was found in the environment, it is well below levels that might cause significant adverse effects. Even under highly conservative calculations, it would take a child drinking a gallon of groundwater on a daily basis with the highest reported residue for there to be the possibility of a health effect. As a result, no changes in ALB Program operating procedures are suggested.

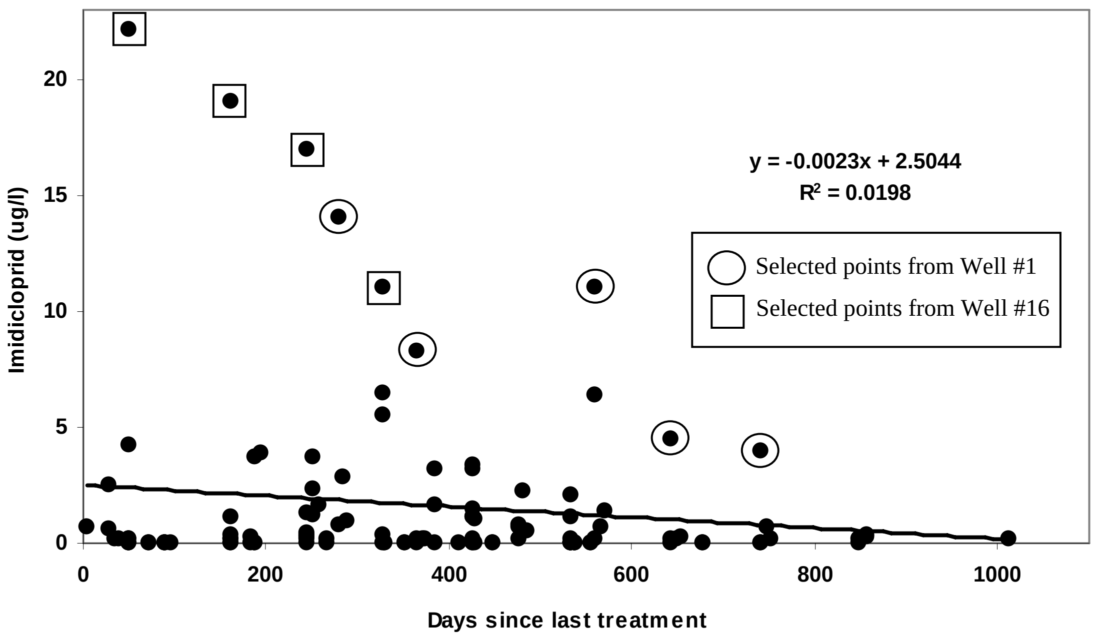


Figure 1: The relationship between imidacloprid residues in wells and the time since the last treatment. Selected data points from Wells #1 and #16 are highlighted.

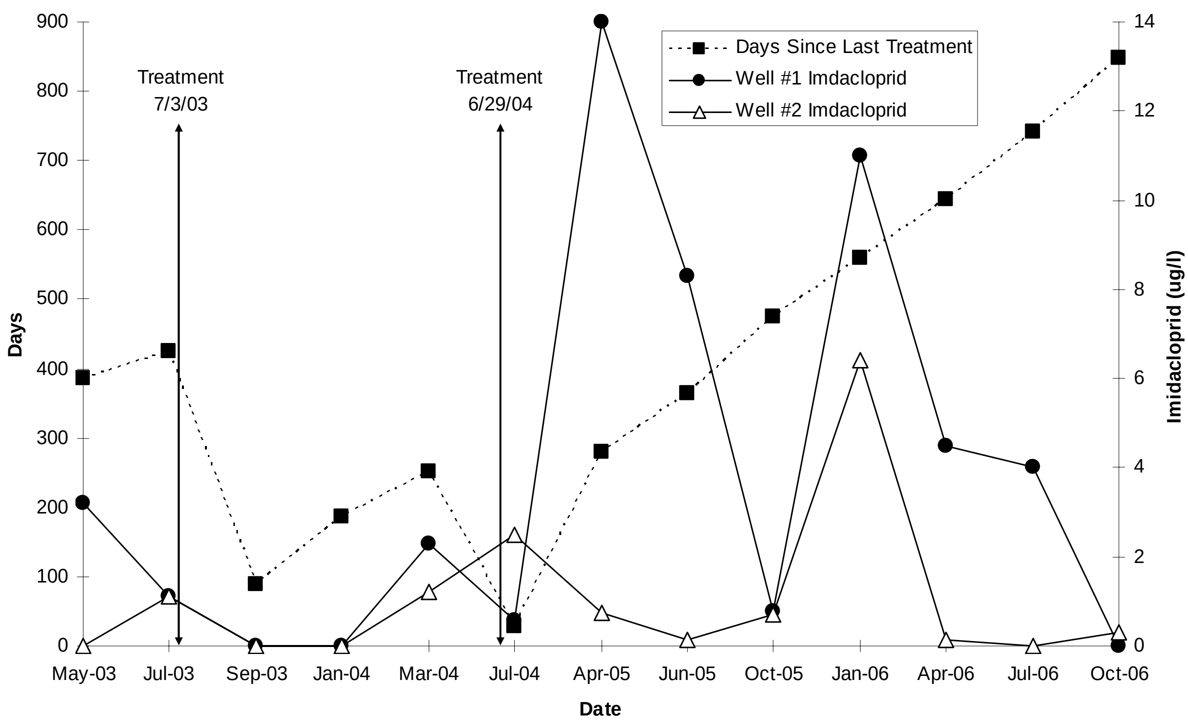
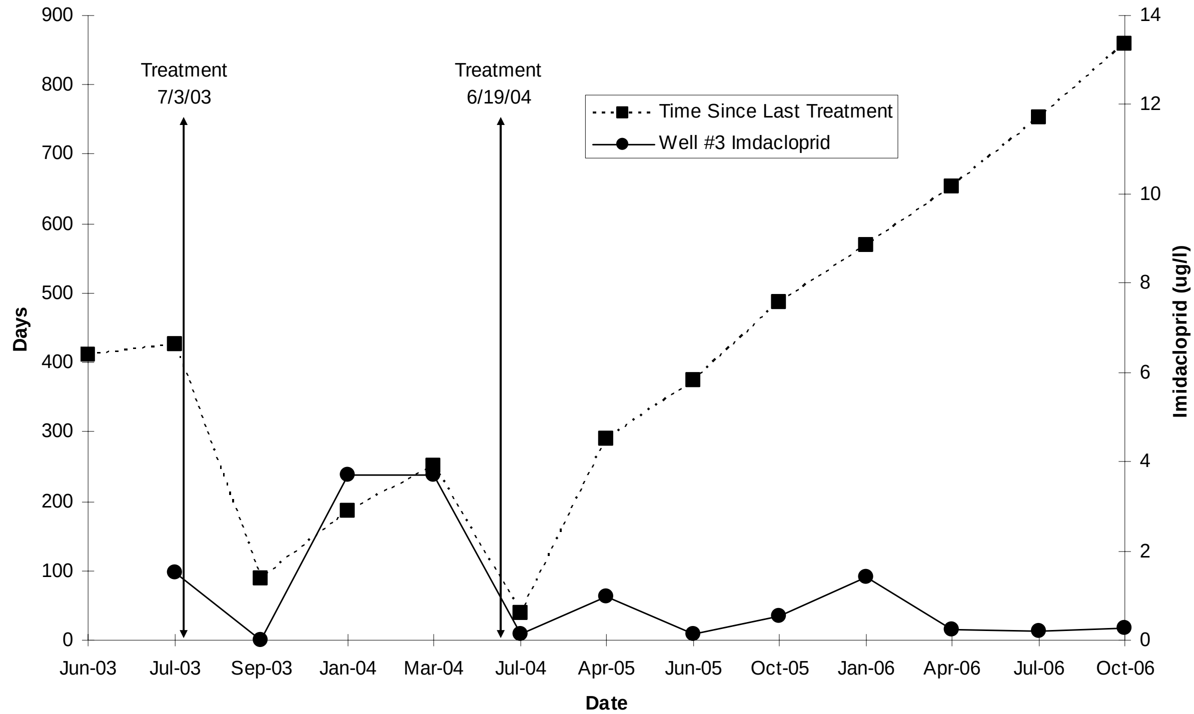


Figure 2: Residue data from Wells #1 and #2 (right axis) plotted through time along with the time since the last treatment (left axis).



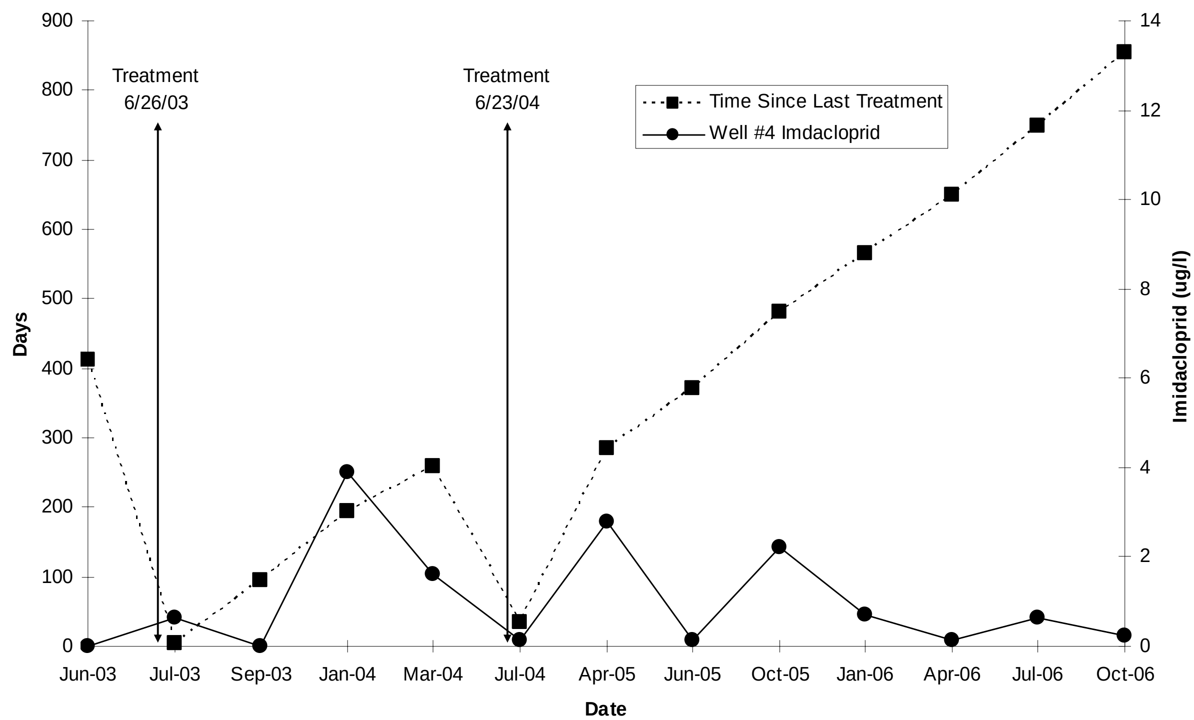


Figure 3: Residue data (right axis) from Well #3 (top) Well #4 (bottom) plotted through time along with the time since the last treatment (left axis). Note that there is a small difference in the time since last treatment in the two graphs.

Figure 4: Locations and treatment information for Wells #1-6, with 600 and 1200 foot radii around Wells #1 and #3. Note the close proximity of wells #1 and #2. Wells #5 and #6 are controls that are outside of the treatment area.

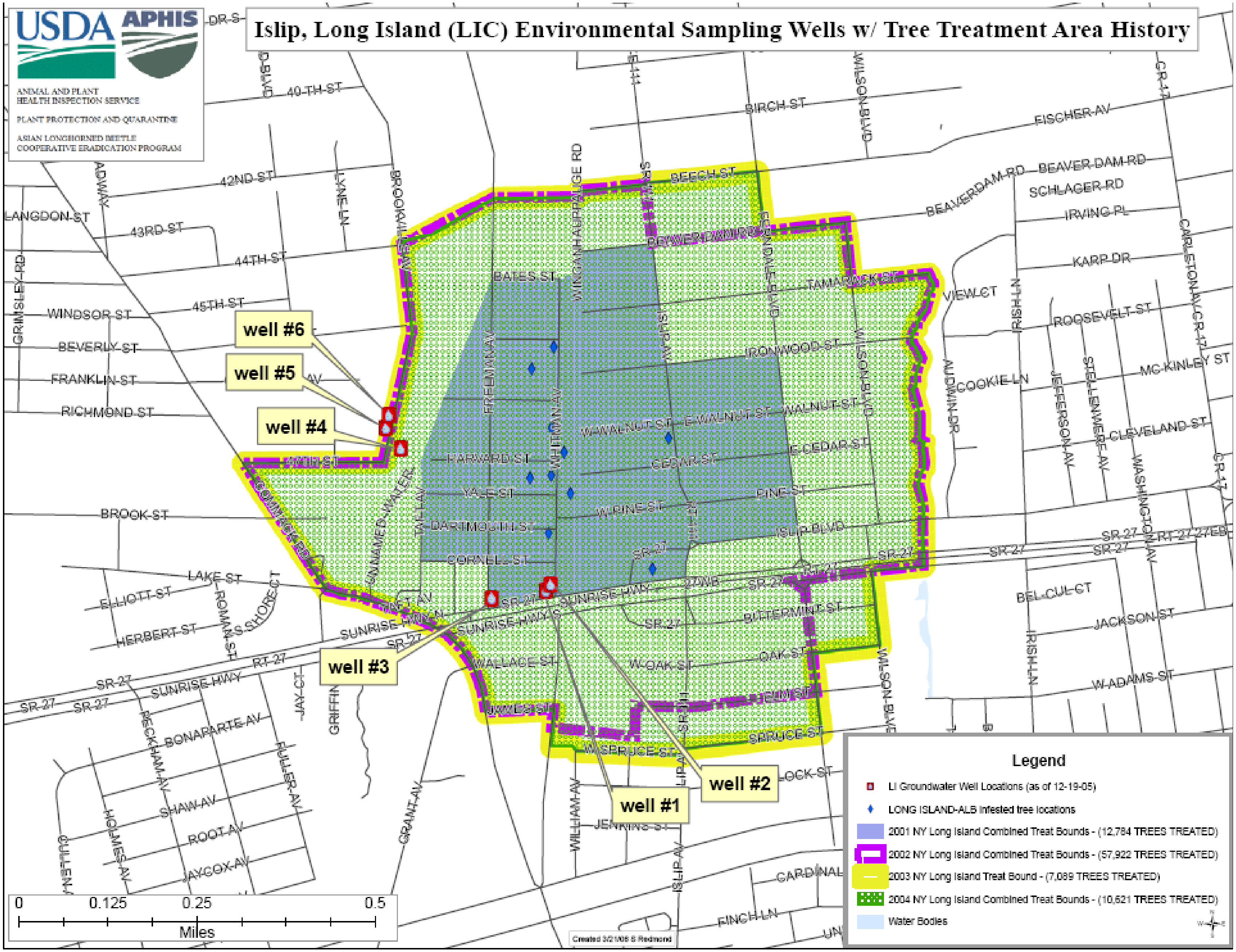


Figure 5 (best viewed/printed in color): Locations and treatment information for wells #1-6. Note the close proximity of Wells #1 and #2.

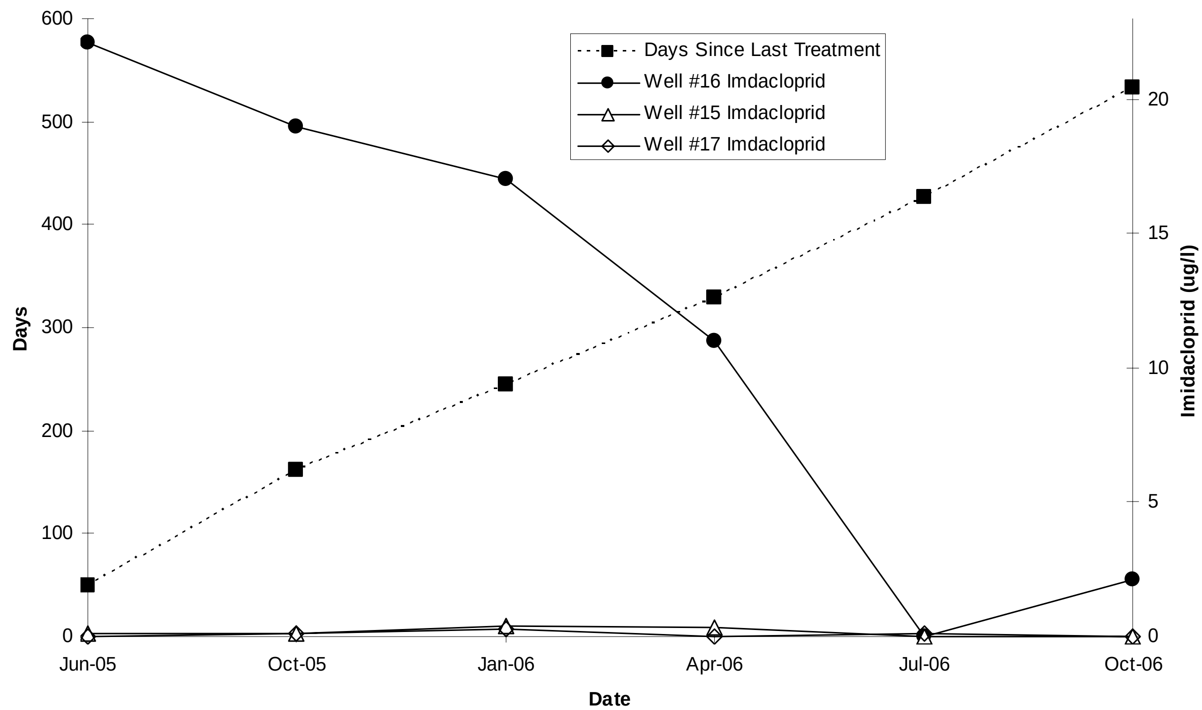


Figure 6: Residue data (right axis) from Wells #15-17 plotted through time along with the time since the last treatment (left axis).

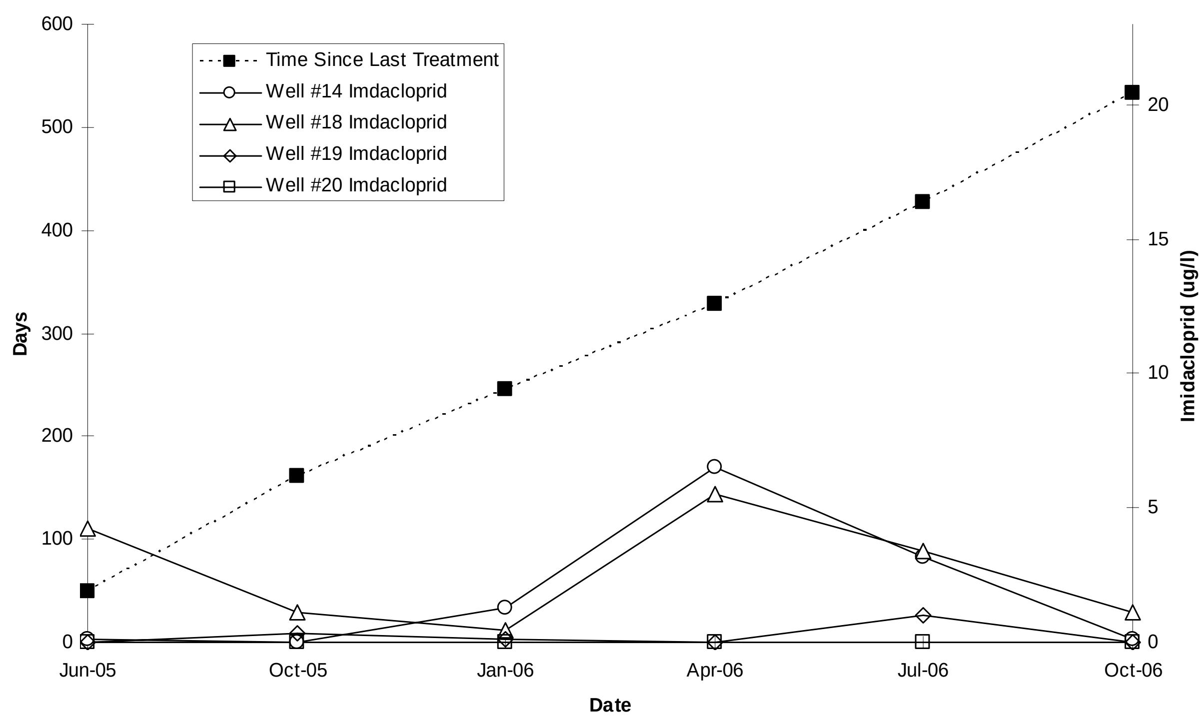


Figure 7: Residue data (right axis) from Wells #14, 18-20 plotted through time along with the time since the last treatment (left axis).

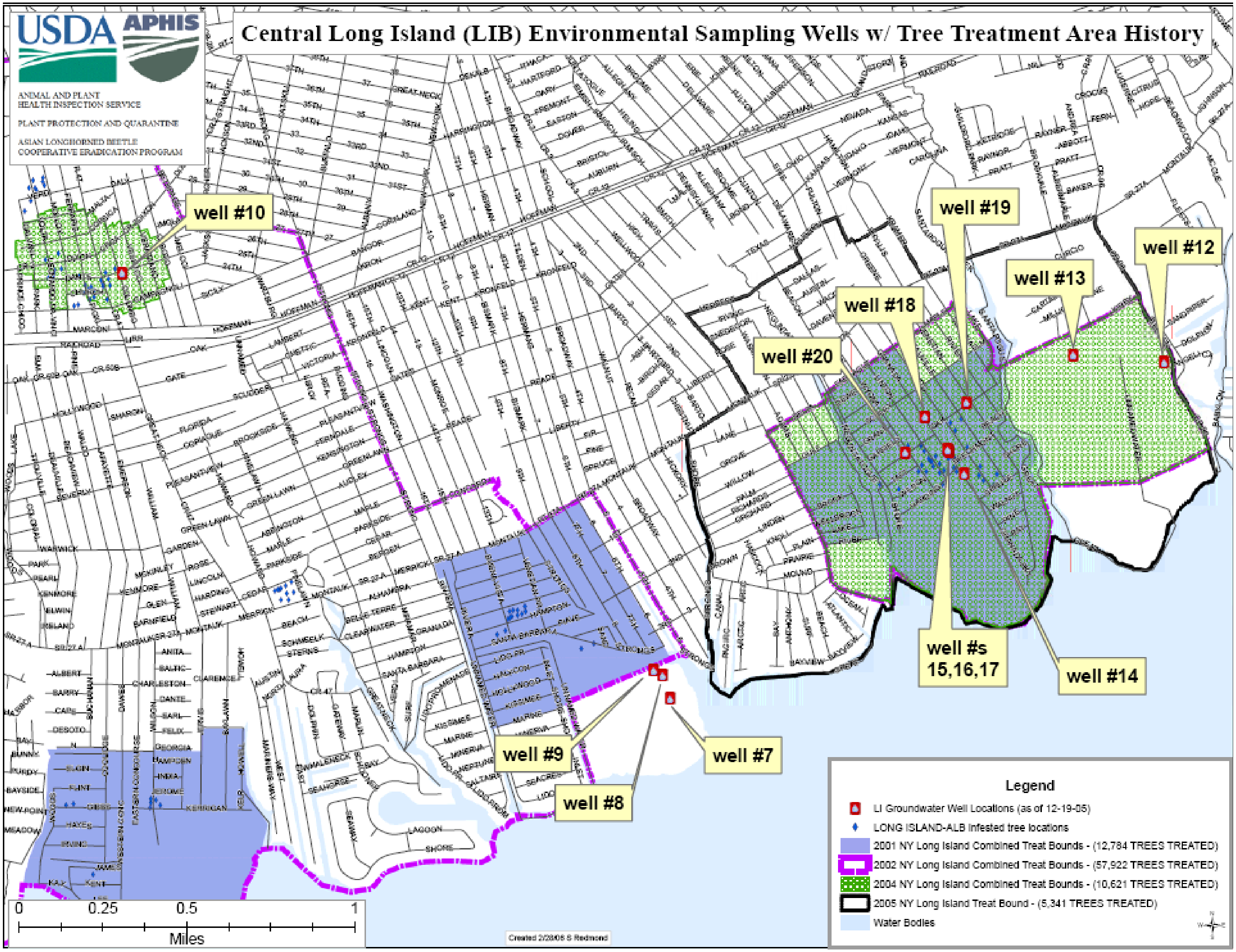
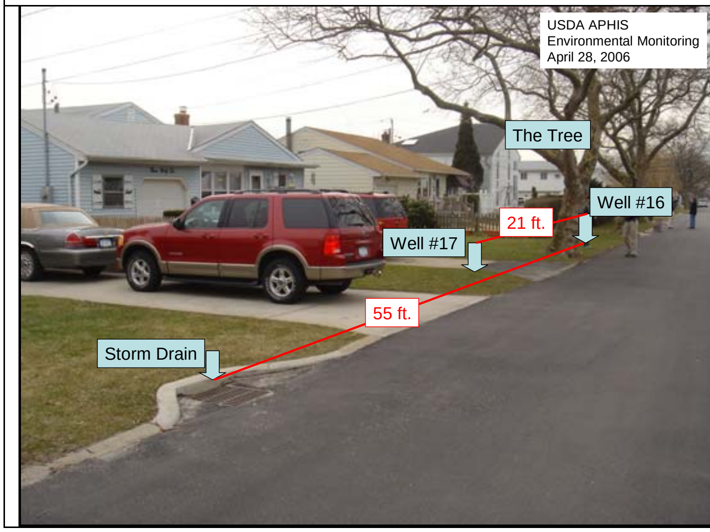


Figure 8 (best viewed/printed in color): Locations and treatment information for Wells #7-20. Note the close proximity of Wells #15-17.

Photo 1: Location of Wells #16 and #17	Photo 2: Location of Wells #15 and #16
	

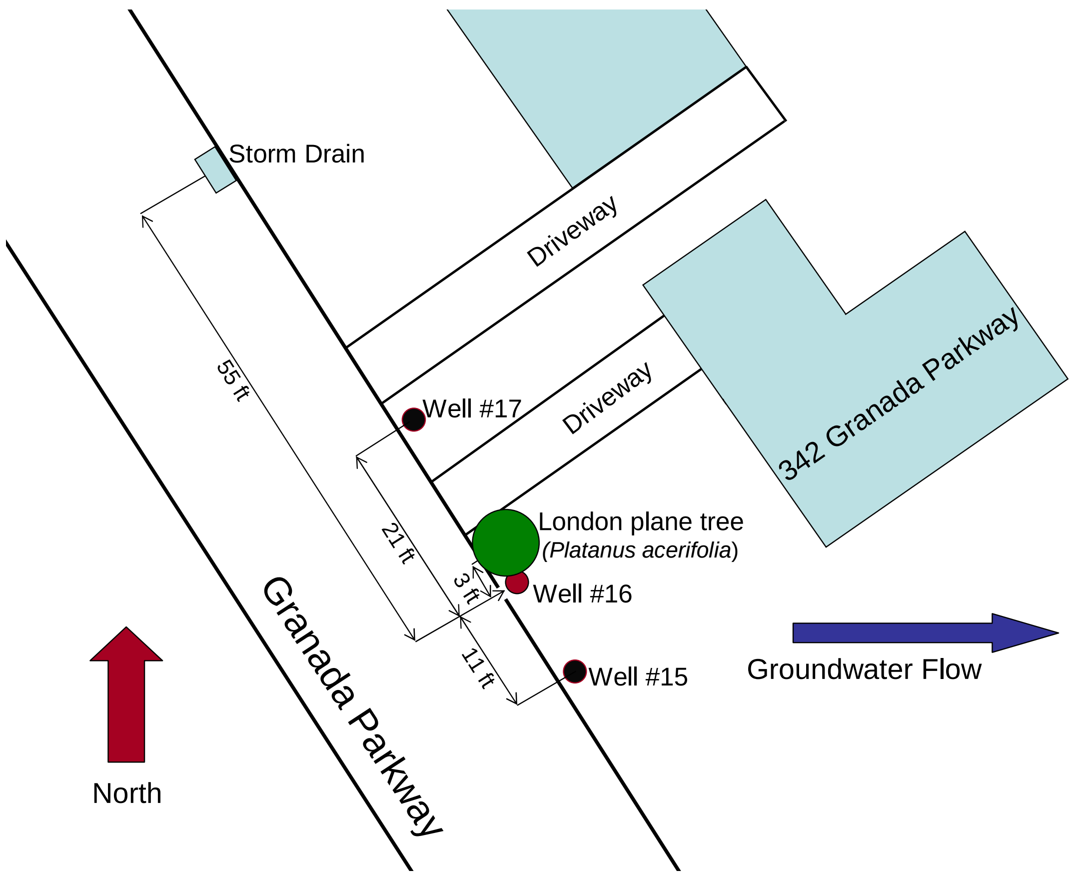


Figure 9: Photos and schematic showing the locations of Wells #15-17 and surrounding environment.

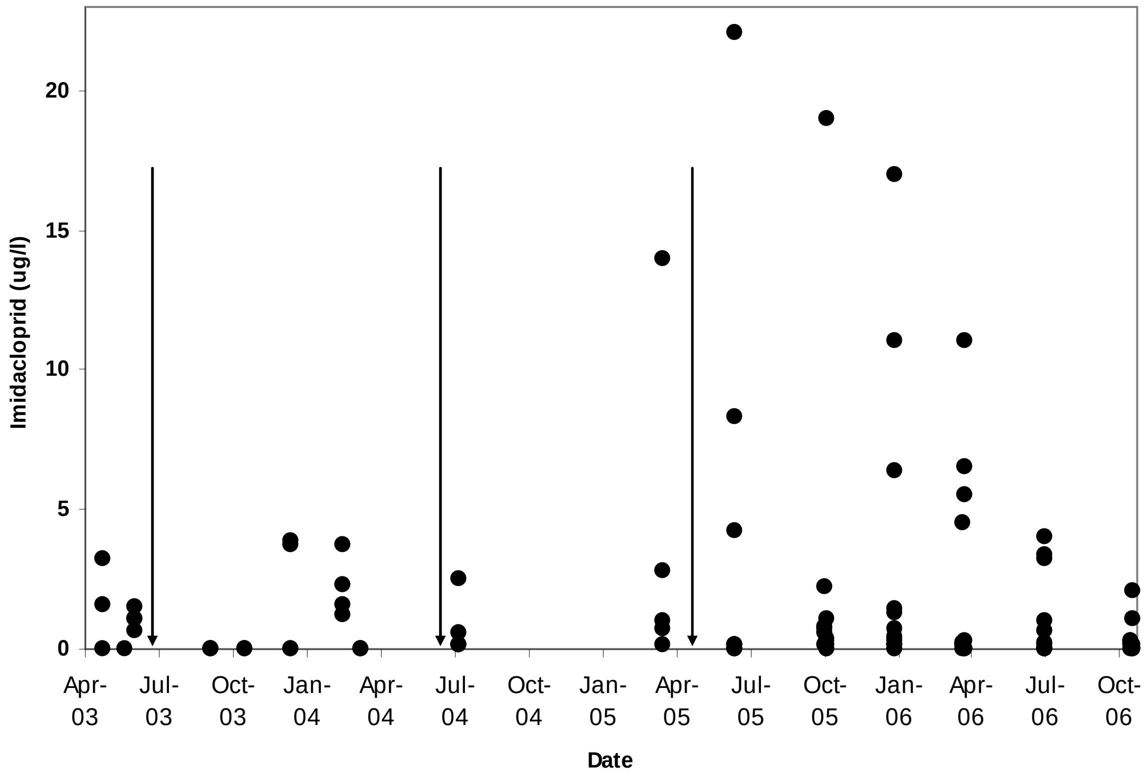


Figure 10: Imidacloprid residue data from all wells plotted through time. Arrows show approximate treatment dates, although not all trees near all wells were treated on those dates. Treatment details by well are in Tables 1-20.

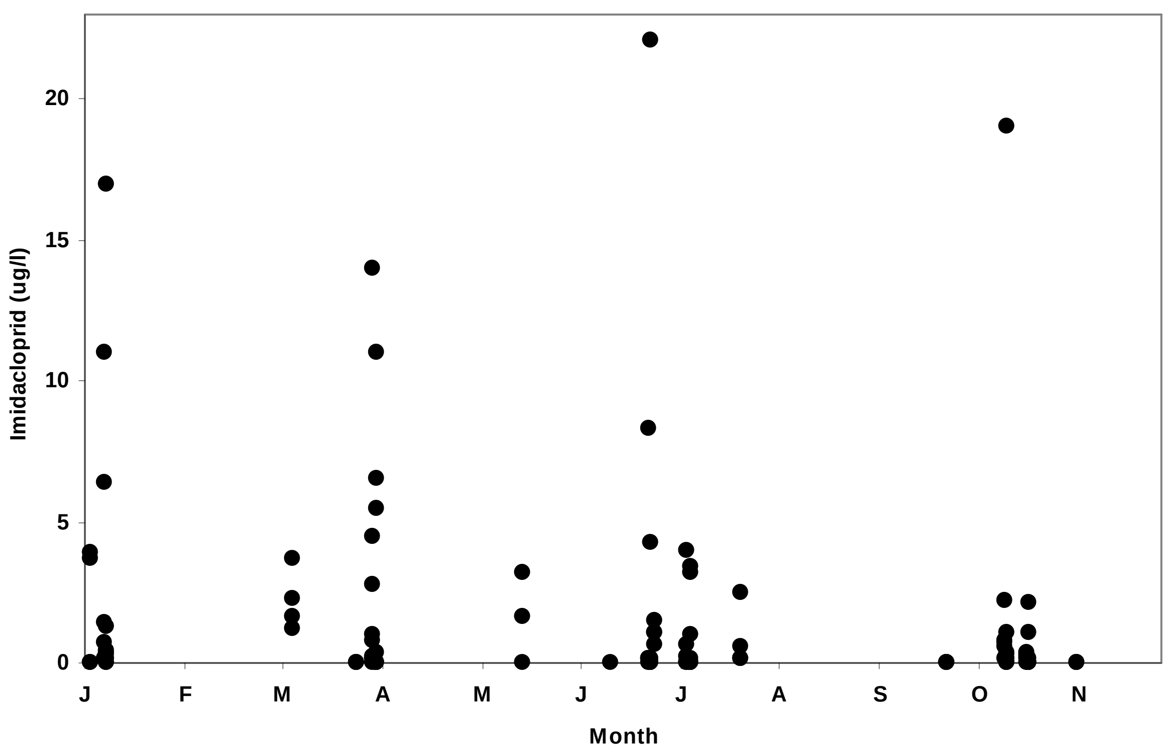


Figure 11: Imidacloprid residue data from all wells plotted by month and collapsed by year, in order to investigate seasonal effects.

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#1 North Service Rd	6/15/01									
# of trees treated	6/15/01									
up-gradient:	5/1/02	5/21/03	385 days	6.10 ft	10 ft	3.2				
2001 = 104	5/1/02	7/1/03	426 days	5.04 ft		1.1				
2002 = 145	7/3/03	9/30/03	89 days	5.97 ft		NEG				
2003 = 103	7/3/03	1/6/04	187 days	5.46 ft		NEG	NEG	NEG	NEG	
	7/3/03	3/10/04	251 days	5.85 ft		2.3	NEG	NEG	NEG	
	6/29/04	7/28/04	29 days	6.24 ft		0.58		NEG	NEG	
	6/29/04	4/4/05	279 days	4.91 ft		14	NEG	NEG	NEG	
	6/29/04	6/29/05	365 days	6.09 ft		8.3	0.12	NEG	NEG	
	6/29/04	10/18/05	476 days	3.72 ft		0.79	NEG	NEG	NEG	
	6/29/04	1/10/06	560 days	5.11 ft		11	TRACE	NEG	NEG	
	6/29/04	1/10/06	560 days	5.11 ft			TRACE			(two leaf samples collected)
	6/29/04	4/4/06	644 days	5.86 ft		4.5	NEG	NEG	NEG	
	6/29/04	4/4/06	644 days	5.86 ft			NEG			(two leaf samples collected)
	6/29/04	7/11/06	742 days	5.24 ft		4		NEG	NEG	leaf sample too small for analysis
	6/29/04	10/25/06	848 days	5.55 ft		TRACE	NEG	NEG	NEG	

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 1

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#2 Whitman Ave	6/15/01									
# of trees treated	6/15/01									
up-gradient:	5/1/02	5/21/03	385 days	5.89 ft	10 ft	NEG				
2001 = 104	5/1/02	7/1/03	426 days	5.06 ft		1.1				
2002 = 145	7/3/03	9/30/03	89 days	5.95 ft		NEG		NEG	NEG	
2003 = 103	7/3/03	1/6/04	187 days	5.44 ft		NEG	NEG	NEG		
	7/3/03	3/10/04	251 days	5.86 ft		1.2	NEG	NEG	NEG	
	6/29/04	7/28/04	29 days	6.26 ft		2.5	NEG	NEG	NEG	
	6/29/04	4/4/05	279 days	4.95 ft		0.75	NEG	NEG	NEG	
	6/29/04	6/29/05	365 days	6.14 ft		TRACE	NEG	TRACE	NEG	
	6/29/04	10/18/05	476 days	3.80 ft		0.7	NEG	NEG	NEG	
	6/29/04	1/10/06	560 days	5.14 ft		6.4	0.29	NEG	NEG	
	6/29/04	1/10/06	560 days	5.14 ft			TRACE			(two leaf samples collected)
	6/29/04	4/4/06	644 days	5.88 ft		TRACE	NEG	NEG	NEG	
	6/29/04	4/4/06	644 days	5.88 ft			NEG			(two leaf samples collected)
	6/29/04	7/11/06	742 days	5.29 ft		NEG			NEG	
	6/29/04	10/25/06	858 days	5.58 ft		0.32	NEG			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 2

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection

Asian Longhorned Beetle Program, NY May 2003 - October 2006

Well Location	Treatment Date of Host Trees	Sample Date	Time Since Last Treatment	Depth to Water	Well Depth	Water Samples (USDA) (µg/l)	Leaf Samples (mg/l)	Soil Sample top 1" (mg/l)	Soil Sample 2-6" depth (mg/l)	Comments
#3 Freeman Ave	6/14/01									
# of trees treated	6/14/01									
up-gradient:	5/1/02	5/21/03	385 days	5.54 ft	9 ft	1.6				
2001 = 104	5/1/02	7/1/03	426 days	3.47 ft		1.5				
2002 = 145	7/3/03	9/30/03	89 days	4.28 ft		NEG				
2003 = 103	7/3/03	1/6/04	187 days	3.79 ft		3.7	0.26	NEG		
	7/3/03	3/10/04	251 days	4.20 ft		3.7	NEG	NEG		
	6/19/04	7/28/04	39 days	4.47 ft		TRACE	NEG	NEG		
	6/19/04	4/4/05	289 days	3.35 ft		0.99	0.21	NEG		
	6/19/04	6/29/05	375 days	4.43 ft		TRACE	0.26	NEG		
	6/19/04	10/18/05	486 days	2.10 ft		0.55	0.42	NEG		
	6/19/04	1/10/06	570 days			1.4	TRACE	NEG	NEG	
	6/19/04	4/4/06	654 days	4.24 ft		0.24	TRACE	NEG	NEG	
	6/19/04	7/11/06	752 days	3.69 ft		0.21	NEG	NEG	NEG	2nd leaf sample too small for analysis
	6/19/04	10/25/06	858 days	3.94		0.26	0.34	NEG	NEG	

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 3

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#4 Brookville Ave lot	5/17/02	6/17/03	412 days	1.33 ft	4.2 ft	NEG				
# of trees treated	6/26/03	7/1/03	5 days	not done		0.65				
up-gradient:	6/26/03	9/30/03	96 days	1.88 ft		NEG	2.3	0.31	0.28	
2002 = 3590	6/26/03	1/6/04	194 days	1.27 ft		3.9	0.85	0.16	0.18	
2003 = 2570	6/26/03	3/10/04	258 days	1.56 ft		1.6	0.79	0.15	0.09	
	6/23/04	7/28/04	35 days	2.00 ft		TRACE	2.5	0.13	TRACE	
	6/23/04	4/4/05	285 days	1.11 ft		2.8	0.32	0.15	NEG	
	6/23/04	6/29/05	371 days	2.02 ft		TRACE	0.24	TRACE	TRACE	
	6/23/04	10/18/05	482 days	1.96 ft		2.2	0.18	NEG	NEG	
	6/23/04	1/10/06	566 days	1.5 ft		0.69	TRACE	NEG	NEG	
	6/23/04	1/10/06	566 days	1.5 ft			NEG			(two leaf samples collected)
	6/23/04	4/4/06	650 days	1.37 ft		TRACE	TRACE	TRACE	NEG	
	6/23/04	4/4/06	650 days	1.37 ft			TRACE			(two leaf samples collected)
	6/23/04	7/11/06	748 days	1.79 ft		0.65	NEG	NEG	NEG	
	6/23/04	7/11/06	748 days	1.79 ft			NEG			(two leaf samples collected)
	6/23/04	10/25/06	854 days	1.53 ft		0.22	TRACE	NEG	NEG	
	6/23/04	10/25/06	854 days	1.53 ft			NEG			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 4

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#5 216 Brookville Ave		9/30/03		3.93 ft	8.7 ft	NEG				
Negative control		1/6/04		3.63 ft		NEG	NEG			
		3/10/04		3.83 ft		NEG	NEG			
		7/28/04		4.04 ft		TRACE				
		4/4/05		3.36 ft		NEG				
		6/29/05		4.06 ft		NEG		NEG		
		10/18/05		2.72 ft		NEG	NEG	NEG		
		1/10/06		3.4 ft		NEG	TRACE			
		4/4/06		3.81 ft		NEG	NEG			
		7/11/06		3.60 ft		NEG		NEG	NEG	
		10/25/06		3.70 ft		NEG	NEG			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 5

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#6 224 Brookville Ave		9/30/03		4.77 ft	9.8 ft	NEG				
Negative control		1/6/04		4.42 ft		NEG	NEG	NEG		
		3/10/04		4.62 ft		NEG	NEG	NEG	NEG	
		7/28/04		4.87 ft		NEG		NEG	NEG	
		4/4/05		4.13 ft		NEG	NEG	NEG	NEG	
		6/29/05		4.86 ft		NEG		NEG		
		10/18/05		3.51 ft		NEG	NEG	NEG		
		1/10/06		4.22 ft		NEG				
		4/4/06		4.58 ft		NEG				
		7/11/06		4.40 ft		NEG		NEG	NEG	leaf sample too small for analysis
		10/25/06		4.38 ft		NEG				

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
Indian Island Wells	6/12/01									
#7	5/21/02	11/10/03	538 days	5.44 ft	7.0 ft	NEG				
# of trees treated										
up-gradient:										
2001 = 3266										
2002 = 4556										

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#7A – **new well placed 3/30/04 ~25' SW of old well due to salt water intrusion	5/21/02	3/30/04		4.20 ft	7.0 ft	NEG				

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
Indian Island Well #8	5/21/02	11/10/03	538 days	3.90 ft	7.0 ft	NEG				
# of trees treated	5/21/02	3/30/04	679 days	4.20 ft		NEG				
up-gradient:										
2001 = 3266										
2002 = 4556										

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
Indian Island Well #9	5/21/02	11/10/03	538 days	4.02 ft	7.0 ft	NEG				
# of trees treated	5/21/02	3/30/04	679 days	4.50 ft		NEG				
up-gradient:										
2001 = 3266										
2002 = 4556										

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 10

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#10 190 Colombo Ave	6/26/02	4/4/05	1013 days	10.29 ft	15 ft	TRACE				
Copiague (T5-12)	6/29/04	6/29/05	365 days	11.63 ft		NEG				
	6/29/04	10/18/05	476 days	9.33 ft		TRACE				
	6/29/04	1/10/06	560 days	??		TRACE				
	6/29/04	4/4/06	644 days	11.0 ft		NEG				
	6/29/04	7/11/06	742 days	10.53 ft		NEG				
	6/29/04	10/25/06	848 days	10.96		NEG				

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#12 Bergen Pt Golf Course (clubhouse) (BPGC-2)	7/2/02									
	7/29/04									
	4/19/05	6/30/05	72 days	3.03 ft	30 ft	NEG				
	4/19/05	10/19/05	183 days	2.81 ft	30 ft	0.29	2.1	NEG		
	4/19/05	1/11/06	267 days	3.18 ft		TRACE				
	4/19/05	4/5/06	351 days	3.03 ft		NEG				
	4/19/05	7/12/06	449 days	3.12 ft		NEG	0.91	NEG	NEG	
	4/19/05	10/26/06	555 days	3.17 ft		NEG	0.56	NEG	NEG	

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection

Asian Longhorned Beetle Program, NY May 2003 - October 2006

Well Location	Treatment Date of Host Trees	Sample Date	Time Since Last Treatment	Depth to Water	Well Depth	Water Samples (USDA) (µg/l)	Leaf Samples (mg/l)	Soil Sample top 1" (mg/l)	Soil Sample 2-6" depth (mg/l)	Comments
#13 Bergen Pt Golf Course (fairway) (BPGC-1)	7/2/02									
	7/29/04									
	4/19/05	6/30/05	72 days	1.56 ft	30 ft	NEG				
	4/19/05	10/19/05	183 days	1.46 ft	30 ft	NEG	1.9			
	4/19/05	1/11/06	267 days	1.75 ft		NEG				
	4/19/05	4/5/06	351 days	1.57 ft		NEG		NEG	TRACE	
	4/19/05	7/12/06	449 days	1.66 ft		NEG		NEG	NEG	
	4/19/05	10/26/06	555 days	1.72 ft		NEG	1.6	NEG	NEG	

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#14 420 Granada Pkwy	7/13/02									
Lindenhurst	8/2/04	4/11/05	252 days	??	10 ft					sample taken before split sampling re-initiated w/ USDA
(L1-84R)	5/11/05	6/30/05	50 days	3.04 ft	10 ft	TRACE				
	5/11/05	10/19/05	161 days	2.35 ft	10 ft	NEG	5.8			
	5/11/05	1/11/06	245 days	3.1 ft		1.3	2.8			
	5/11/05	4/5/06	329 days	3.16 ft		6.5	2.7			
	5/11/05	7/12/06	427 days	3.11 ft		3.2	0.65			
	5/11/05	10/26/06	533 days	3.11 ft		TRACE	0.53			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#15 342 Granada Pkwy Lindenhurst (L2-54B)	7/13/02									
	8/2/04									
	5/11/05	5/17/05	6 days	??	10 ft					sample taken before split sampling re-initiated w/ USDA
	5/11/05	6/30/05	50 days	3.32 ft	10 ft	TRACE				
	5/11/05	10/19/05	161 days	2.52 ft	10 ft	TRACE	4.9			
	5/11/05	1/11/06	245 days	3.33 ft	10 ft	0.37				
	5/11/05	4/5/06	329 days	3.49 ft		0.32				
	5/11/05	7/12/06	427 days	3.37 ft		NEG				
	5/11/05	10/26/06	533 days	3.34 ft		NEG	0.65			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#16 342 Granada Pkwy Lindenhurst (L2-54)	7/13/02									
	8/2/04	4/13/05	254 days	3.25 ft	8 ft					sample taken before split sampling re-initiated w/ USDA
	5/11/05	5/17/05	6 days	3.25 ft	8 ft					sample taken before split sampling re-initiated w/ USDA
	5/11/05	6/30/05	50 days	3.51 ft	10 ft	22.1				
	5/11/05	10/19/05	161 days	2.71 ft	8 ft	19	2.4			
	5/11/05	1/11/06	245 days	3.52 ft	10 ft	17				
	5/11/05	4/5/06	329 days	3.67 ft		11		0.35	NEG	
	5/11/05	7/12/06	427 days	3.55 ft		NEG				
	5/11/05	10/26/06	533 days	3.52 ft		2.1	0.79			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#17 342 Granada Pkwy	7/13/02									
Lindenhurst	8/2/04									
(L2-54A)	5/11/05	5/17/05	6 days	??	10 ft					sample taken before split sampling re-initiated w/ USDA
	5/11/05	6/30/05	50 days	3.5 ft	10 ft	NEG				
	5/11/05	10/19/05	161 days	2.36 ft	10 ft	TRACE	4.6			
	5/11/05	1/11/06	245 days	3.18 ft	10 ft	0.27				
	5/11/05	4/5/06	329 days	3.35 ft		NEG				
	5/11/05	7/12/06	427 days	3.22 ft		TRACE				
	5/11/05	10/26/06	533 days	3.19 ft		NEG	0.82			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#18 245 Granada Pkwy Lindenhurst	7/13/02									
	8/3/04	4/19/05	260 days	??	10 ft					sample taken before split sampling re-initiated w/ USDA
	5/11/05	6/30/05	50 days	4.06 ft	10 ft	4.23				
	5/11/05	10/19/05	161 days	3.15 ft	10 ft	1.1	1.8			
	5/11/05	1/11/06	245 days			0.44				
	5/11/05	4/5/06	329 days	4.38 ft		5.5				
	5/11/05	7/12/06	427 days	4.17 ft		3.4				
	5/11/05	10/26/06	533 days	3.11 ft		1.1	0.91			

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 18

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#19 227 Venetian Ave at Oak Ave Lindenhurst	7/13/02									
	8/2/04									
	5/10/05	5/19/05	9 days	??	10 ft					
	5/10/05	6/30/05	51 days	6.02 ft	10 ft	NEG		NEG	NEG	
	5/10/05	10/19/05	162 days	4.83 ft	10 ft	0.33	0.75	NEG	NEG	
	5/10/05	1/11/06	246 days			TRACE	0.23	NEG	NEG	
	5/10/05	4/5/06	330 days	6.2 ft		NEG		NEG	NEG	
	5/10/05	7/12/06	428 days	6.03 ft		1		NEG	NEG	
	5/10/05	10/26/06	534 days	8.95 ft		NEG	0.17	NEG	NEG	
	5/10/05	10/26/06	534 days	8.95 ft			0.13			(two leaf samples collected)

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Environmental Monitoring – Groundwater Wells Down-Gradient of Trees Treated with Imidacloprid by Trunk Injection										
Asian Longhorned Beetle Program, NY May 2003 - October 2006										
Well Location	**Treatment Date of Host Trees**	**Sample Date**	**Time Since Last Treatment**	**Depth to Water**	**Well Depth**	**Water Samples (USDA) (µg/l)**	**Leaf Samples (mg/l)**	**Soil Sample top 1" (mg/l)**	**Soil Sample 2-6" depth (mg/l)**	**Comments**
#20 275 Wyona Ave at Mckinley Ave Lindenhurst	7/13/02									
	7/30/04									
	5/10/05	5/17/05	7 days	??	10 ft					sample taken before split sampling re-initiated w/ USDA
	5/10/05	6/30/05	51 days	2.15 ft	7 ft	NEG		NEG	NEG	
	5/10/05	10/19/05	162 days	1.37 ft	7 ft	NEG	0.33	NEG	NEG	
	5/10/05	1/11/06	246 days			NEG	TRACE	TRACE	NEG	
	5/10/05	4/5/06	330 days	2.22 ft		NEG	0.2	NEG	NEG	
	5/10/05	4/5/06	330 days	2.22 ft			NEG			(two leaf samples collected)
	5/10/05	7/12/06	428 days	2.11 ft		NEG		NEG	NEG	
	5/10/05	10/26/06	534 days	2.14 ft		NEG	0.15	NEG	NEG	
	5/10/05	10/26/06	534 days	2.14 ft			0.29			(two leaf samples collected)

Water: Neg <0.06 ug/l (some <0.075ug/l), Trace <0.2 ug/l
Leaf Litter: Neg <0.03 mg/l, Trace <0.1 mg/l
Soil: Neg <0.03 mg/l, Trace <0.1 mg/l

2006 samples are highlighted

Table 20