Preliminary Executive Summary of the Wood-Pawcatuck Watershed Association Regarding Water Quality in the Vicinity of Richmond Stump Dump

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August 2006

Summary Statement

From April to August of 2006, the Wood-Pawcatuck Watershed Association employed a number of tools, including in-situ electronic data loggers, to assess changes in specific conductance in Canob Brook, as well as chemical analysis of water samples to investigate concentrations of boron in the brook and a nearby groundwater well. The purpose of this material is to contribute to the assessment of environmental effects from the disposal of woody debris, and subsequent pesticide applications, which have occurred in the vicinity of the above site known as "Richmond Stump Dump," located between Route 3 and Route 95 at the intersection of Skunk Hill Road, in Richmond RI.

A preliminary search of the literature was made in an effort to determine the probable effects of woody debris on stream ecology. A list of 477 references was found in the Aquatic Science and Fisheries Abstracts literature. Perusal of this literature did not locate any documents clearly demonstrating adverse effects of natural woody debris, except for changing the substrate composition when found in excessive amounts.

It is known that a boric-acid-containing cockroach bait (Niban) has been applied at the site in an attempt to control a massive cockroach infestation of properties surrounding the dump site. However, only limited information on the effects of boron on living organisms has been provided to date. This information is found in Annex 1 of this report (attached). It states that the granular bait Niban contains 5 percent boric acid as the active ingredient. The bait remains active outdoors until it is exposed to 1.5 to 2 inches of rainfall. This suggests that the boric acid dissolves into the rain water which then disperses underground or into open streams.

The information which follows summarizes the critical levels of boron for several organisms and compares these with results of toxicity from chemical analysis of water from various sites near the stump dump. Annex 2 illustrates the effects of boron on a wide spectrum of organisms.

There are two primary messages from these data: first, that fish (especially early life history stages) are the most sensitive aquatic organisms to boron; and second, the suggestion that a boron level greater than 1 mg/liter[1] of water may cause adverse environmental effects, especially to early life history stages of fishes and amphibians.

An additional search was made of the literature base of Aquatic Science and Fisheries Abstracts in order to obtain additional published reports of critical boron values. Annex 3 contains these values and the names of the organisms involved. It seems evident from these data that early life history stages of amphibians as well as fish may be very sensitive to boron. Although the critical values of boron are somewhat variable, it should be noted that boron levels above 1mg/liter may be damaging to some life history stages for both fishes and amphibians. As a minimum precaution, the use of boron containing pesticides should be restricted to the fall and winter periods when sensitive larval stages of these organisms are not available.

The preliminary data available from the chemical analysis for boron is shown in Annex 4. This data set has been validated by a second analysis. It is evident that the levels of boron found in 3 of the 4 sites examined had boron levels above 1µg/liter (micrograms per liter) of water. Note that the boron levels reported in our analysis are in parts per billion (ppb), whereas the boron toxicity data reported in the literature is in parts per million (ppm). This means that, currently at least, the levels of boron found in our study are well below the levels which might be dangerous to humans and/or aquatic organisms.

However, we found that the levels of boron in ground water increase closest to the dumpsite. The presence of boron in groundwater near the dump site raises the question of whether these concentrations will increase or decrease over time. Because only one sampling round for boron was conducted, we believe that the water quality at this dump site deserves careful monitoring over a longer period of time (e.g. a year).

Our water analysis was limited to boron, but there may be other elements or compounds leaching from the dumpsite. An attempt will be made to analyze both groundwater and surface run-off for

[1] Generally, the concentration unit mg/L is equivalent to ppm (parts per million). Similarly, µg/L is equivalent to ppb (parts per billion)

those toxic compounds that are typically associated with dump sites. These results will be made available to all interested parties.

Discussion of Electronic Data Logging of DO, pH, Temperature, and Specific Conductance Above and Below the Stump Dump Site

From January 27 to February 9, and from March 31 to April 19, 2006, WPWA deployed two YSI Data Sonde data loggers near the confluence of two first-order streams that flow into the Wood River above and below the site of the Richmond Stump Dump. These data loggers recorded measurements of dissolved oxygen, pH, temperature, and specific conductivity once every 15 minutes for the entire period of deployment. Data from the dissolved oxygen, pH, and temperature showed insignificant variations between the two sampling locations. However, specific conductivity data, which indicates the presence of dissolved particles in the water, showed statistically significant differences between the two sampling locations.

The first stream, referred to as Unnamed Stream, emerges out of Moonshine Swamp just east of Rte 95 and flows west into the Wood River north of Skunk Hill Road. The second stream is Canob Brook, which emerges out of Canob Pond and flows northwest to enter the Wood River just south of Skunk Hill Road. Based on assessments of the USGS topography map, it is determined to be unlikely that the Unnamed Stream receives ground water or overland flow from the Richmond Stump Dump, since it is up gradient about ½ mile from the site. Canob Brook is very likely to receive both ground water and over land flow from the site because it is directly adjacent just south of the site, and down gradient.

Canob Brook consistently showed 4 times higher values of specific conductivity than the Unnamed Stream, with an average of 981 µS/cm vs. 251 µS/cm respectively. Both of these readings significantly exceed values recorded at other sampling sites on the lower Wood River conducted around the same time of year, where an average of 127 µS/cm was recorded. The slight elevation in specific conductivity in the Unnamed Stream (versus the lower Wood River figure) may be attributed to the contribution of salts and other contaminants of runoff from Interstate 95. The elevated Canob Brook data is indicative of an upstream source of dissolved particles entering the stream, most likely the Richmond Stump Dump, based on its upgradient location. Data at the Unnamed Stream, above the Stump Dump, shows significantly less influence of dissolved particles.

Annex 1. Summary Data for the Granular Bait (Niban)

Source: http://www.nisuscorp.com/niban.html

This weatherized granular perimeter bait is used outdoors or indoors to kill and control cockroaches, ants, crickets, silverfish and carpenter ants. Niban's weatherized granules don't degrade from heat or sunlight and will last through four inches of rain. Niban is the one bait that will continue to work because Niban has no known resistance and is virtually odorless.

Niban kills the microoganisms in the insect's stomach and blocks enzyme production causing starvation. And since it affects none of the insect's major systems, they can't develop resistance.

MSDS available online. www.nisuscorp.com

Nisus Corporation, 100 Nisus Drive, Rockford, TN 37853 (800) 264-0870

NIBAN Frequently Asked Questions

(source: http://www.nisuscorp.com/nibanfaq.html)

What is Niban Granular Bait and Niban-FG ?
They are granulated baits containing five percent boric acid as the active ingredient and a combination of both protein and carbohydrate attractants.

What insects will Niban Granular Bait and Niban-FG control?
They are labeled for the control of cockroaches, crickets, silverfish, and ants, including carpenter ants.

Does either bait have an odor?
There is no detectible pesticide odor. The only odor is that of the food based attractant.

Will Niban irritate skin?
No.

What is the difference between Niban Granular Bait and Niban-FG?
Both products consist of the same formulation but have one significant difference. Niban Granular Bait contains only coarse particles; excellent for outdoor broadcast and perimeter applications. Niban-FG is made up of very small particles which allows it to be used in any type of dusting equipment. Niban-FG is excellent for indoor crack and crevice treatments.

How can I apply Niban Granular Bait?
With a mechanical spreader, power duster, plunger type duster or by hand.

What type of equipment is needed to apply Niban-FG?
Any type of dust applicator will work. For crack and crevice treatments, a bellows duster works best. For broadcast applications in attics and crawl spaces, the use of a power duster cuts application time considerably.

Can I use Niban-FG outdoors?
Yes. Small ants and silverfish often invade homes from the exterior. They build up in considerable numbers in flower beds, refuse areas, and under chips adjacent to a structure. It is frequently more effective to treat the source of the problem rather than trying to eliminate them after they have entered. Apply in a two-foot band around the perimeter of the home.

How long will Niban remain effective outdoors?
Based on studies, Niban Granular Bait remained effective until it was exposed to between one and a half and two inches of rainfall.

Annex 2. Information from www.GreenFacts.org Related to Boron Toxicity

Source: http://www.GreenFacts.org/boron/1-2/boron-5.htm

What are the effects of boron on organisms in the environment?

Bacteria are relatively tolerant towards boron. Acute and chronic effect concentrations range between 8 and 340 mg boron/litre, with most values greater than 18 mg boron/litre. More sensitive are protozoa. Tests with Entosiphon and Paramecium yielded 72-h no-observed-effect concentrations (NOECs) and EC3 values between 0.3 and 18 mg boron/litre.

Boron is an essential micronutrient for cyanobacteria and diatoms. Standard chronic tests with freshwater green algae resulted in no-effect concentrations between 10 and 24 mg boron/litre. Blue-green algae appear to be similar in sensitivity, with an 8-day EC3 of 20 mg boron/litre.

Based on acute toxicity values, invertebrates are less sensitive to boron than microorganisms. For several species, 24- to 48-h EC50 values ranged from 95 to 1376 mg boron/litre, with most values in the 100-200 mg boron/litre range. Chronic toxicity studies with Daphnia magna gave NOECs ranging between 6 and 10 mg boron/litre. Slightly lower NOEC values were obtained from laboratory and field biocenosis studies. The 28-day laboratory study consisting of six trophic stages yielded a NOEC of 2.5 mg boron/litre. Long-term outdoor pond and field studies (not including fish) yielded NOECs up to 1.52 mg boron/litre.

Acute tests with several fish species yielded toxicity values ranging from about 10 to nearly 300 mg boron/litre. Rainbow trout (Oncorhynchus mykiss) and zebra fish (Brachydanio rerio) were the most sensitive, providing values around 10 mg boron/litre.

The toxicity of boron to early life stages of fish has been documented for several species in reconstituted water. Embryonic and early larval stages of rainbow trout, largemouth bass (Micropterus salmoides), channel catfish (Ictalurus punctatus), and goldfish (Carassius auratus) were exposed to boron, as boric acid or borax, from fertilization up to 8 days post-hatch in soft or hard water. Neither water hardness nor the form of boron consistently affected embryo-larval survival of fish. Rainbow trout was the most sensitive species. The NOECs for rainbow trout ranged from 0.009 to 0.103 mg boron/litre.

The effect of natural dilution water on boron toxicity was determined by using surface waters collected from three locations, with boron concentrations of 0.023, 0.091, and 0.75 mg/litre. No adverse effects were determined up to 0.75 mg boron/litre. Lowest-observed-effect concentrations (LOECs) ranged from 1.1 to 1.73 mg boron/litre. One test using deep (600 m) well-water, typically used for aquatic toxicity tests, from a contract laboratory located in Wareham, Massachusetts, USA, yielded a NOEC of >18.0 mg boron/litre. Hence, reconstituted water exposures appeared to overestimate the toxicity determined in natural waters, possibly as a result of nutrient deficiency in the former.

Boron has been known since the 1920s to be an essential micronutrient for higher plants, with interspecies differences in the levels required for optimum growth. Boron plays a role in cell division, metabolism, and membrane structure and function. Boron in the form of borates occurs naturally in fruits, nuts, and vegetables. There is a small range between deficiency and excess uptake (toxicity) in plants. Boron deficiencies in terrestrial plants have been reported in many countries. Boron deficiency is more likely to occur in light-textured, acid soils in humid regions because of boron's susceptibility to leaching. Boron excesses usually occur in soil solutions from geologically young deposits, arid soils, soils derived from marine sediments, and soils contaminated by pollutant sources, such as releases from coal-fired power plants and mining operations. Irrigation water is one of the main sources of high boron levels resulting in toxicity in the field.

Mallard (Anas platyrhynchos) duckling growth was adversely affected at dietary levels of 30 and 300 mg boron/kg, and survival was reduced at 1000 mg/kg."

Source & © : IPCS "Environmental Health Criteria (EHC) 204", Summary of the Report, Chapter 1.1.5. For more information, see the full IPCS document
Effects on Other Organisms in the Laboratory and Field, Chapter 9

See also Chapter 10.5.3 Evaluation of effects on the environment: Risk evaluation
from full report

The effect of boron has been determined for several types of organisms in the environment, but more information is available for some types of organism than for others. Some of the information covers the effects of short-term exposure to boron, while other information focuses on long-term or chronic exposure. The information may be available for several types of organism within a group – for example, for several types of invertebrates – or it may be available for only one type. The amounts and types of information available for different species are important in the overall judgement of the relative sensitivity of environmental organisms to boron in the environment.

The table below shows the information available for different organisms, and the types of tests and the approximate number of different species for which these tests were carried out.

Table: "Reported critical boron levels for several types of environmental organism"

Type of organism	**Type of effect(s) reported**	**Boron concentration in the water**
Bacteria	Mixture of **acute** and **chronic** effects, for several types of bacteria	8 - 340 mg/litre (mainly above 18 mg/litre)
Protozoa	First very small effects, for 2 types of protozoa	0.3 - 18 mg/litre
Freshwater green algae	Highest concentration with no effect (**NOEC**), for several types of algae	10 - 24 mg/litre
Blue-green algae	First very small effect for 1 type of blue-green algae	20 mg/litre
Invertebrates	**Acute** effects for several types of invertebrates	95 to 1376 mg/litre (mainly 100-200 mg/litre)
Water flea (Daphnia magna)	Highest concentration with no effect (**NOEC**), found in many **chronic** tests for this one invertebrate type	6 - 10 mg/litre
Fish	**Acute** effects in several types of fish	10 to nearly 300 mg/litre
Rainbow trout	Chronic tests with standard laboratory water (**NOEC**)	0.009 - 0.103 mg/litre
Rainbow trout	Chronic tests in several natural waters (**NOEC**)	0.75 - > 18 mg/litre

The data in the table show that **bacteria** are much less sensitive to boron, compared to other chemicals. **Protozoa** are somewhat more sensitive. **Algae**, for which boron is an essential nutrient, also have low sensitivity to boron. **Invertebrates** also have a low boron sensitivity, as determined from many long-term studies. **Fish** are the most sensitive species to boron.

The experts assembled by the World Health Organization (WHO) to write the IPCS document decided, based on the sensitivity of the various tests and the numbers of tests for the different types of organisms, that a boron level of 1 mg/litre water would cause no adverse effect on the environment. As well as information on the toxicity of boron in the aquatic environment, information is also available for one predator which eats aquatic species. In mallard, a **water fowl** species, boron can affect duckling growth at dietary intake levels of 30 - 300 mg/kg weight of animal, and can reduce survival at 1000 mg/kg weight of animal.

Boron is an essential micronutrient for **plants**, but different plant species require different boron levels for optimum growth. Boron plays several roles within the plant cell: in cell division, in the metabolism, and in the cell membrane. As a result, boron (in the form of borates) occurs naturally in fruits, nuts, and vegetables (see table on Boron content of some common foods in question 3.2).

In plants, there is only a narrow margin between boron deficiency and excess boron uptake leading to toxicity. Boron deficiencies in terrestrial plants have been reported in many countries. Boron deficiency occurs when boron leaches out of the soil, particularly in humid regions with light-textured, acid soils. Boron excesses usually occur in soil solution, i.e. the water found in the soil containing soluble material, from geologically young deposits, arid soils and soils derived from marine sediments. It also occurs in soils contaminated by human activities, such as releases from coal-fired power plants and mining operations. Irrigation water containing boron is one of the main sources of high boron levels leading to toxicity on agricultural land.

Source: Pesticide Action Network, North America. http://www.pesticideinfo.org

Toxicity Studies for Boron on All Organism Groups

						Toxic Dose				
Common Name ***Scientific Name***	**Effect**	**Measurement**	**Life Stage**	**Study Time**	**Toxicity Endpoint**	**Mean**	**Min**	**Max**	**Conc Units**	**Con Typ**
Aquatic Plants										
Duckweed *Lemma minor*	Growth	Growth, general	20 COLONIES OR 40 FRONDS	4d	EC50	60,000	-	-	uG/L	T
Nematodes and Flatworms										
Turbellarian, flatworm *Dugesia dorotocephala*	Behavior	Behavioral changes, general	18 - 20 MM	1 h	NR	-	100	10,000	ug/L	T
Phytoplankton										
Algae, algal mat *Algae*	Biochemistry	Phycocyanin	GREEN, BLUE-GREEN, DIATOMS	NR h	NR	-	118	2,020	ug/L	T
Algae, algal mat Algae	Population	Population change, general	GREEN, BLUE-GREEN, DIATOMS	NR h	NR	-	118	2,020	ug/L	T

Annex 3. Additional Boron Toxicity Results to Analysis Species

Critical Boron Levels for Selected Organisms

Type of Organism	Reported Effect	Boron Concentration in Water
Duckweed (Spirodella polyrrhiza)	Frond production reduced Abnormal and dead fronds	(3.55 mg/l) (18.9 - 22.4 mg/l)
Amphibian Eggs	Deformed Offspring Low Hatching Success	Approx. 50 mg/l 1.5 mg/l
Fish (Oncorhinchus mykiss)	Acute toxicity for embryolarval stages	0.1 - 18 mg/l
Insect (Chironomus decorus) 4th instar	Significant growth decrease	20 mg/l
Fish (Oncorhinchus kisutch) under yearling	Acute toxicity	12.2 mg/l

Annex 4. WPWA Boron Analysis Data from sites in the Vicinity of the Richmond Stump Dump

Richmond Stump Dump 7/10/06

Waypoint	Site	pH	Electric Conductivity	Temperature (degrees Celcius)	Boron Concentration in ppb
SD1	Canob Brook @ confl. Wood River	7.5	762 uS/cm	22.4	5
SD2	Private Groundwater Well (private property)	7.6	226 uS/cm	16.9	6.1
SD3	Canob Brook below pond @ bridge	7.5	800 uS/cm	24.8	1.1
SD4	Unnamed Brook at KG Ranch Road (private property)	7.5	253 uS/cm	24.8	BD
SD5	Wood River @ KG Ranch Road (private property)	7.4	90 uS/cm	20.8	not analyzed
none	Private GW Well - Filtered from tap (private property)	6.7	618 uS/cm	25.9	not analyzed

BD = below detection limit

All samples on private property obtained with permission.

Date of analysis: 7/24/06