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TRANSPORT OF MERCURY FROM SOILS TO STREAMS IN TWO FORESTED CATCHMENTS ON MT. MANSFIELD, VERMONT

A Thesis Presented

by

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Abstract

Mercury (Hg) contamination in freshwater fish is a widespread environmental problem throughout the northern hemisphere. Atmospheric sources of Hg are thought to be responsible for increasing Hg burdens in Lake Champlain but the sources and mechanisms of transport and accumulation are not well understood. Though most Hg deposited in soils accumulates or is revolatilized into the atmosphere, other studies have suggested that the small percentage of Hg mobilized from soils to streams is significant and may be enough to contribute 25–75% of Hg reaching lakes. In order to better understand the transport of Hg from soils to streams, I sampled soil solution and stream water from three locations in two small forested catchments in Underhill Center, VT. I first identified methods of collecting soil water, tested the suitability of using custom-made passive capillary wick samplers, then used these devices to collect soil solution samples for this study. Soil solution and stream samples collected during snowmelt and rain storms between April and November 1997 were analyzed for Hg, dissolved organic carbon (DOC), color, trace elements, and major ions. Mercury in Oa and B horizon soil water ranged from 1.1 to 34.9 ng L^{-1} and 0.1 to 10.2 ng L^{-1}, respectively. In streams, dissolved Hg was 0.9–4.1 ng L^{-1} and total (dissolved + particulate) Hg was 0.9–9.2 ng L^{-1}. In soil water and stream water, Hg was positively correlated with DOC and color. Mercury concentrations followed a pattern similar to other trace metals known to form complexes with organic acids, such as Al, Cu, and Pb. The bulk of Hg in these streams during high flow is associated with particulate matter, but the small and continual contribution of dissolved Hg from soils and groundwater is also a significant route of Hg export from these forested ecosystems.

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Appendix A

Comprehensive Literature Review

INTRODUCTION

Mercury (Hg) contamination in freshwater fish is a widespread environmental problem throughout the northern hemisphere. Locally, Hg has been given the highest priority for management action in Lake Champlain because of elevated levels in fish (Lake Champlain Management Conference, 1996). Mercury has natural and anthropogenic sources, but the amount released into the biosphere has increased since the beginning of the industrial age (Fitzgerald *et al.*, 1998). Although the problem is widespread, there is substantial variation in Hg levels within different lakes and fish species even in pristine areas (Nillson and Håkanson, 1992).

Environmental Hg enters a lake by three primary routes: direct deposition onto the lake surface, surface runoff from the watershed, and groundwater inflow. In the Lake Champlain basin, more than 90% of the water in Lake Champlain first passes through the 21,150 km^2 watershed before reaching the lake (Lake Champlain Management Conference, 1996). Forests cover 64% of the watershed area (personal communication, Vermont Center for Geographic Information, 1998), therefore, the presence of Hg in forest soils in the watershed likely influences the loading of Hg into the surface waters that drain into Lake Champlain. Mercury in forest soils is strongly bound to soil constituents or revolatilized into the atmosphere and only a minor fraction is transported from the soils to surface waters. This small percentage nevertheless may be enough to account for 25–75% of the Hg reaching lakes (Lee *et al.*, 1994).

In order to better understand the mechanisms of Hg transport, this thesis focuses on Hg in forest soils, soil water, and stream water within two small forested catchments in the Lake Champlain basin. This literature review summarizes the current knowledge of Hg and its relationship to soil and stream water. Research on Hg in the Lake Champlain basin has recently been reviewed by Shanley *et al.* (in press) and will not be duplicated here.

Mercury Toxicity and Sources of Mercury

Mercury (as methylmercury) is a neurotoxin that can be completely absorbed into the blood and distributed to all tissues, including the brain. Mercury poisoning can cause irreversible damage to the central nervous system as well as sensory, visual, and auditory functions and to areas concerned with coordination (Hamasaki *et al.*, 1995). It can also pass through the placenta to a fetus and the fetal brain (USEPA, 1997). Many states in the USA, including Vermont, have set limits on the consumption of certain species of freshwater fish based on health risks posed by Hg. Piscivorous wildlife species such as loons, eagles, minks, otters, and the endangered Florida panther are also at risk (USEPA, 1997). Adverse effects of Hg on fish and wildlife include death, reduced reproductive success, impaired growth and development, and behavioral abnormalities (Friedmann *et al.*, 1996; Weiner and Spry, 1996; USEPA, 1997).

Mercury is widely used in industry to make fluorescent lamps, thermostats, batteries, instruments that measure temperature and pressure, dental amalgams, paints, pharmaceuticals, and fungicides. The largest amount of Hg used in manufacturing in the USA is in the production of chlorine and caustic soda by mercury cell chlor-alkali plants (Fitzgerald, 1993; USEPA, 1997). In areas where there are no direct industrial discharges, high Hg levels are thought to be the result of atmospheric Hg pollution. Globally, the dominant sources of atmospheric Hg are manufacturing, waste incineration, coal combustion, and non-ferrous metal smelting (Engstrom and Swain, 1997).

The amount of Hg entering the atmosphere from anthropogenic sources considerably exceeds natural emissions from volcanoes, forest fires, and the surface of the ocean (Fitzgerald, 1993). In addition, a substantial fraction of oceanic Hg emissions represents recycling of Hg that entered the marine environment from anthropogenic sources. Lake sediment records provide evidence that remote regions have received significant inputs of anthropogenic Hg by long-range atmospheric transport (Fitzgerald *et al.*, 1998). One study estimated that the pre-industrial atmospheric flux of Hg was 3.7 $\mu g\ m^{-2}\ year^{-1}$, whereas the modern rate is approximately 12.5 $\mu g\ m^{-2}\ year^{-1}$, a 3.4-fold increase in 140 years (Swain *et al.*, 1992). In recent decades, however, industrial use of Hg has declined and air pollution controls have caused Hg emissions to decrease (Engstrom and Swain, 1997). Subsequently, localized declines in Hg deposition have been observed in some areas of the upper Midwest U.S., but such declines are not evident in Alaskan ice cores indicating that global Hg emissions have not abated (Engstrom and Swain, 1997).

Mercury Chemistry

As a pure element, Hg is a liquid at -39°–357°C, can vaporize readily, and is only slightly soluble in water. It is a soft acid and as such tends to form covalent bonds rather than ionic bonds. Mercury can form strong complexes with organic compounds. Depending on the redox conditions, Hg may occur in three different valence states: Hg^0 (elemental mercury), Hg^+ in the form of Hg_2^{2+} (mercurous), and Hg^{2+} (mercuric or Hg(II)). Mercurous mercury tends to be unstable and is rarely present in ordinary environmental conditions. The compounds that are most common under environmental conditions are the mercuric salts, $HgCl_2$, $Hg(OH)_2$, and HgS; and the methylmercury compounds, methylmercuric chloride (CH_3HgCl) and methylmercuric hydroxide (CH_3HgOH) (Schuster, 1991; USEPA, 1997).

As noted, solid waste incinerators and coal combustion chambers are major sources of atmospheric Hg. In these sources, nearly all Hg is converted to Hg^0 and vaporized to the exhaust gas system. As exhaust reaches a stack, temperatures decrease and some Hg^0 reacts with other flue gas constituents, oxidizing Hg^0 to Hg^{2+}. It is generally assumed that the Hg^{2+} in flue gases is in the form of $HgCl_2$ because chlorine occurs naturally in coal and is also present in municipal solid waste emissions from the incineration of chlorinated plastics and other chlorine-containing wastes (Carpi, 1997). The Hg^{2+} emitted directly from a point source is quickly removed from the atmosphere locally by precipitation or dry deposition and has a residence time of hours to months. Elemental Hg^0 on the other hand, has a residence time of about one year because of its high vapor pressure and low water solubility (Carpi, 1997; USEPA, 1997; Fitzgerald *et al.*, 1998). As a result, Hg^0 is distributed fairly evenly in the troposphere (USEPA, 1997) and more than 95% of atmospheric Hg is in the gaseous Hg^0 form (Nater and Grigal, 1992). Concentrations of Hg^{2+} are assumed to be minimal in the free troposphere because of efficient wet removal (Shannon and Voldner, 1995).

Mercury Deposition

Direct deposition of Hg onto land or water comes in the form of dry deposition (gaseous and to a lesser extent particulate phase) and wet precipitation. In Underhill Center, VT, total atmospheric Hg deposition was estimated to be 425 and 463 mg ha^{-1} yr^{-1} for two years beginning March 1994 (Scherbatskoy *et al.*, 1998). Dry deposition accounted for most of this Hg flux, with only 75 and 93 mg ha^{-1} yr^{-1} arriving as wet deposition in those two years. Between December 1992 and August 1994, vapor phase Hg concentrations ranged from 1.2 to 4.2 ng m^{-3} without much seasonal variation (Scherbatskoy *et al.*, 1997), particle phase Hg ranged from 1 to 43 pg m^{-3} with the highest concentrations during the winter, and precipitation concentrations ranged from 1.5 to 26 ng L^{-1} with highest concentrations generally during the summer months.

When deposited on land, Hg^{2+} can bind tightly to certain soil components, primarily humic matter. Soil Hg^{2+} can be reduced to elemental Hg by the action of free radicals in the presence of humic acid (Takamatsu *et al.*, 1983), or can be methylated to form methylmercury (methyl-Hg). Reduced Hg may revolatilize back into the atmosphere as Hg^0. Lindberg (1996) suggests that the forest floor is an active site of Hg^0 exchange. He estimated that 657 mg Hg ha^{-1} yr^{-1} was volatilized from soil at a Tennessee site. Bishop *et al.* (1998) estimated a flux of 90 mg ha^{-1} yr^{-1} from soils at a site in Sweden. Revolatilization of Hg may account for the seasonal variability observed in ambient air in Nova Scotia, where total gaseous Hg levels are highest in the summer when days are longer and warmer (Beauchamp *et al.*, 1997).

Mercury Cycling

Of the Hg that is not volatilized, Hg^{2+} and methyl-Hg may remain in the soil or be transported through the watershed to a water body via runoff and leaching (USEPA, 1997). Most Hg originating from atmospheric deposition, however, is immobilized as organic complexes in the upper horizons of soils (Meili, 1991a), and only a minor fraction of the Hg is transported from the soils to surface waters. In central and southern Sweden, this small percentage of Hg released from soils (< 0.1%) is enough to contribute 25 to 75% of Hg reaching lakes (Lee *et al.*, 1994). Mercury in forest soils will be discussed in greater detail in the next section.

Although Hg^{2+} and methyl-Hg complexes in soils are potentially available for biotic uptake and translocation, the storage of Hg in biomass is small compared to fluxes between soil layers (Aastrup *et al.*, 1991; USEPA, 1997). Root uptake of Hg may occur, but translocation of Hg within the plant appears to be minimal (Padberg and Stoeppler, 1991; Schuster, 1991; USEPA, 1997). Nevertheless, Bishop *et al.* (1998) found Hg concentrations in the range of 10 to 16 ng L^{-1} in xylem sap in Norway spruce and Scots pine. Mercury in soil water at their study sites ranged from 20 to 170 ng L^{-1}, indicating some exclusion of Hg at the root level. Grosheva

(1993) measured Hg concentrations in several mushroom species, which had a range of 0.19 to 0.43 µg g^{-1} (wet weight). Mercury in tree wood and lichen was also within this range.

Whereas Hg does not appear to be transported from roots to tree leaves, studies have shown that Hg does accumulate in leaf tissue as a result of atmospheric exposure, consistently increasing in foliage throughout the growing season and peaking in litterfall (Lindberg, 1996; Rea *et al.*, 1996; Rea, 1998). Mercury on leaves may be washed off by precipitation or held by the leaves and deposited as litterfall to the forest floor (Rea *et al.*, 1996). Annual deposition of Hg to forested areas in the Lake Champlain basin in 1994 was estimated to be 11.7 µg m^{-2} yr^{-1} in throughfall and 13 µg m^{-2} yr^{-1} in litterfall (Rea *et al.*, 1996). The deposition of Hg in precipitation only accounted for 7.9 µg m^{-2} $year^{-1}$, or 32% of the 1994 below-canopy total (Rea *et al.*, 1996).

Movement into Aquatic Systems

In a freshwater environment, Hg can enter an ecosystem directly via atmospheric deposition and indirectly from deep or shallow groundwater discharge or runoff. The importance of each pathway varies depending on the local conditions. In Lake Michigan, for example, atmospheric deposition accounts for approximately 80% of Hg input and 17% is riverine input (Mason and Sullivan, 1997). In Lake Champlain, relative importance of these inputs is probably reversed, given the basin's large watershed:lake ratio. Cleckner *et al.* (1995) found Hg in Lake Champlain to be significantly correlated with several crustal elements, suggesting a drainage basin or sediment source for Hg in the lake. Average total Hg concentrations of filtered (0.45 µm) water collected in Lake Champlain 1.6 km west of Burlington was 3.4 ng L^{-1} for the surface microlayer, 3.2 ng L^{-1} for 0.3 m depth, and 2.2 ng L^{-1} for 15 m (Cleckner *et al.*, 1995). Once in a body of water, Hg can remain in the water column, leave the lake from drainage water, revolatilize into the atmosphere, settle into the sediment, or be taken up by aquatic biota

(USEPA, 1997). Most of the Hg in the water column (Hg^{2+} and methyl-Hg) is bound to organic matter, either dissolved or suspended as particles. Studies indicate that 25–60% of Hg-organic complexes are particle-bound in the water column (USEPA, 1997). Mercury concentrations in lakes tend to be positively correlated with dissolved organic carbon (DOC) (Lee and Iverfeldt, 1991; Meili, 1991b; Mierle and Ingram, 1991; Nillson and Håkanson, 1992; Driscoll *et al.*, 1994; Driscoll *et al.*, 1995) and negatively correlated with pH (Lee and Iverfeldt, 1991; Meili, 1991b; Driscoll *et al.*, 1994; Driscoll *et al.*, 1995).

Methylmercury

Mercury must be methylated to enter the food chain. Typically, less than 10% of the total Hg in a water column exists as a methyl-Hg complex (Lee and Iverfeldt, 1991; Driscoll *et al.*, 1995; USEPA, 1997). Although this amount appears small, Rudd (1995) estimated that runoff of methyl-Hg from upland areas and direct precipitation was sufficient to account for all methyl-Hg accumulated in fish yearly in Swedish lakes. Methylation of Hg^{2+} occurs in the water column and sediment by microbial action and abiotic processes (USEPA, 1997). Anaerobic conditions support the formation of methyl-Hg (Branfireun *et al.*, 1996). Rates of methylation in lakes are positively correlated with water temperature but the influence of temperature is difficult to separate from other seasonal changes, such as increased primary production during the summer (Kelly *et al.*, 1995; Weiner and Spry, 1996). Methylation is also enhanced in waters with high DOC levels. Microbial methylation tends to occur in streams and lakes with significant concentrations of DOC because it is a source of decomposable carbon for microbial populations (Miskimmin *et al.*, 1992; Weiner and Spry, 1996). Often there is an increase in the production of methyl-Hg after flooding a reservoir resulting from inputs of DOC and enhanced microbial methylation of inorganic Hg present in the inundated terrestrial habitats (Kelly *et al.*, 1995;

Weiner and Spry, 1996). Wetlands and peatlands also tend to be net sources of methyl-Hg because they provide anaerobic conditions under which microbial methylation can occur (Branfireun *et al.*, 1996; St. Louis *et al.*, 1996).

Mercury as methyl-Hg bioconcentrates in living organisms. Mason and Sullivan (1997) measured total Hg and methyl-Hg concentrations in phytoplankton, zooplankton, amphipods, and fish species in Lake Michigan. They found that by the third trophic level all Hg was methyl-Hg. Zooplankton had an average methyl-Hg concentration of 12.0 ng g^{-1} and an average total Hg concentration of 64.2 ng g^{-1} dry weight. Bloater, which feed on zooplankton, had an average Hg concentration (all methyl-Hg) of 200.6 ng g^{-1} dry weight, and lake trout, a piscivorous species, had an average Hg (as methyl-Hg) concentration of 551.7 ng g^{-1} dry weight.

The tendency of fish to bioconcentrate Hg is a public health concern. The U.S. Food and Drug Administration (FDA) has set an action level of 1 ppm (1 μg g^{-1}) for Hg in fish. In Vermont, 33% of the fish samples collected for analysis since 1990 have had Hg levels greater than 0.5 ppm, and 10% exceeded 1 ppm (NESCAUM *et al.*, 1998). Some of the highest Hg levels were found in walleye from Lake Champlain. Based on exceedances of that action level, the Vermont Department of Health has issued an advisory that limits the consumption of walleye, lake trout, and smallmouth bass throughout Vermont.

Summary

Mercury cycles in the environment as a result of natural and human activities. In the atmosphere, the dominant form of mercury is Hg^0. In precipitation, natural waters, and soils, Hg is most common as Hg^{2+}. The soil is considered to be a net sink for deposited Hg, but enough may be mobilized to rivers and streams to account for a large amount of Hg in lakes. In the next section, Hg in the soil environment is discussed in greater detail.

MERCURY IN THE SOIL ENVIRONMENT

In upland soils Hg tends to accumulate and only a small amount is released in soil solution. Despite this accumulation, the amount of Hg in uncontaminated soils is very low. Table 1 presents Hg soil concentrations as reported in the literature. This section begins by briefly summarizing major soil forming processes, which will provide background to the behavior of Hg in soils. The major forms of Hg in soil are then identified and Hg adsorption and solubility are discussed. Finally, the section concludes with a description of methods used to collect soil solution.

Soil Processes in Northeast Forests

Soil development in northeast U.S. forests occurs by the movement of organic compounds and inorganic minerals. Organic compounds are produced in the canopy and forest floor and are transported downward through the soil profile by water flow. Organic acids help weather mineral soil in upper soil horizons and form organic-metal complexes that deposit in the lower mineral soil. This section will briefly discuss the chemistry of organic and inorganic solutes present in soils.

In a forested ecosystem, the sources of soluble organic substances in soils are natural depositions of plant residues (from leaves, branches, and reproductive parts) as well as organic matter derived from decomposing roots and root exudates (Pohlman and McColl, 1988). Plant litter is decomposed by microorganisms and leaching moves some of the products downward. Organic material may remain in the O horizon up to 100 years and in the B horizon for 300–1000 years (Thurman, 1985; McDowell and Likens, 1988).

As depth increases in a soil profile, the concentration of organic matter decreases, by bacterial decay or adsorption, and the pH increases (McDowell and Wood, 1984; Thurman, 1985; Drever, 1988; Ross and Bartlett, 1996). Iron and Al hydroxides dissolve in the organic horizon under low pH conditions. As the solution percolates through the soil column, ion-exchange and weathering reactions cause the solution pH to increase until the Fe or Al hydroxide solubility limit is reached and the compounds precipitate out of solution. The metal hydroxides provide adsorption sites for removal of organic anions (Cantrell, 1989). Calcium stabilizes organic matter by cation bridging (Van Cleve and Powers, 1995), and if acid rain leaches Ca out of the soil, the solubility of organic colloids could also increase.

Forms of Mercury in Soils

As noted briefly in the previous section on mercury cycling, the cationic form of mercury, Hg^{2+}, is most common in the soil environment. Because of its strong ability to form complexes, Hg^{2+} rarely occurs in free ionic form under natural conditions (Stiennes, 1990). Ionic mercury can form ligands with several anions, including Cl^-, OH^-, F^-, SO_4^{2-}, and NO_3^-, but the compounds $HgCl_2$ and $Hg(OH)_2$ are the dominant inorganic complexes in natural systems because chloride and hydroxide ions are generally of a sufficient concentration to form these compounds (Thanabalasingam and Pickering, 1985; Schuster, 1991). Mercury can also form strong associations with S. In strongly alkaline soils, the soluble HgS_2^{2-} ion is formed (Stiennes, 1990) and in reducing conditions and acid gley soils, HgS formation is favored (Kabata-Pendias and Pendias, 1992; McBride, 1994). Accurately predicting which Hg compounds might exist in the field, however, is difficult because of the limited knowledge of both the species composition in natural systems and the interactions between Hg species and organic substances or colloidal particles (Schuster, 1991).

Ionic Hg also forms strong complexes with humic matter, in particular, fulvic acids. Mercury apparently has a greater affinity for humic substances than for inorganic ions such as Cl^- and OH^- (Roulet and Lucotte, 1995). Complexes may be formed with the predominant functional groups of organic matter, namely phenolic and carboxylate groups, but recent research has demonstrated the importance of reduced sulfur functional groups in the complexation of Hg to humic substances (Xia *et al.*, 1999). Under acidic oxidizing conditions present in most upland soils in the northeast, these complexes are fairly stable (McBride, 1994).

Mercury as Hg^{2+} tends to be more common than elemental Hg^0 in soils because Hg^0 can be lost by volatilization or oxidized to ionic forms. Under natural conditions, the release of Hg^0 from the soils is probably important in the cycling of Hg in the environment (Stiennes, 1990). Reduction of Hg^{2+} to Hg^0 can be achieved in soils by both biological and chemical reactions (McBride, 1994). It has been reported that rapid conversion of organic and inorganic Hg^{2+} to the elemental state can occur in the presence of humic substances. Bacteria and yeast can also be involved in this transformation, but they may in turn oxidize elemental Hg to ionic Hg (Kabata-Pendias and Pendias, 1992).

Methylmercury is also present in soils in small amounts, but the abiotic and biotic mechanisms of methylation are not fully understood. Mercury can be methylated under anaerobic conditions by soil microbes (McBride, 1994) or by humic substances that release labile methyl groups. Methylation of soil Hg^{2+} can occur from the methyl transfer of vitamin B_{12} to Hg^{2+} (Kelly *et al.*, 1995). Methylated Hg is readily mobile and easily taken up by living organisms, including some plants (Kabata-Pendias and Pendias, 1992).

Accumulation of Hg in the soil is controlled by organic complex formation and by sorption. Mobility of Hg requires dissolution processes and biological and chemical degradation of organomercury compounds (Kabata-Pendias and Pendias, 1992). The next two subsections discuss the adsorption and dissolution of Hg in soils.

Adsorption of Mercury in the Soil

Migration of Hg in the soluble form is thought to be somewhat limited and Hg species are retained in the soils by adsorption. When losses from volatilization are small, the Hg content in surface soils is thought to slowly build up even with low inputs (Kabata-Pendias and Pendias, 1992). According to Schuster (1991), the dominant mechanism for sorption on the solid phase is not ion exchange but stable insoluble inorganic and organic complex formation.

Clay minerals, sesquioxides, and organic material are the three groups of soil components that are responsible for retaining elements in the solid phase (Andersson, 1979). The relative importance of each component depends on the soil type and horizon of the soil profile. It is assumed that Hg^{2+} in acidic soils is mainly attached to organic matter, and in neutral and slightly alkaline soils it is attached to mineral compounds (Stiennes, 1990).

Harris *et al.* (1996) used scanning electron microscopy and electron probe microanalysis to locate, image, and determine how Hg is bound to soil particles from flood plain soil at a contaminated site at Oak Ridge, TN. The authors found that Hg-bearing matter was present in several modes. Mercury was present in discrete µm-sized particles, as fillings in pores and fissures of plant debris, and as coatings on organic and inorganic constituents. In all observations, Hg was found to coexist with S, which was not unexpected because Hg is known to have an affinity for S. Mercury and S entities were observed in association with Ca in numerous cases, which suggested that Ca-rich matter might act as an adsorbing surface for Hg. The authors also observed that the form and associations of Hg-bearing entities were independent of the Hg concentration of the soil (Harris *et al.*, 1996). All concentrations at this site were much higher than uncontaminated sites influenced by atmospheric deposition, however.

New research using synchotron-based X-ray absorption spectroscopy improves the understanding of the relationship between trace levels of Hg and soil organic matter. This research indicates that Hg^{2+} binds with reduced S functional groups, such as thiol and disulfide/disulfane, in complexation with humic substances (Xia *et al.*, 1999). Their results give evidence that Hg^{2+} prefers reduced S-containing functional groups over other functional groups in humic acid. The amount of reduced S is more abundant than Hg in uncontaminated areas, and ranges from 10% of total S in a mineral soil humic substance to more than 50% of total S in an aquatic fulvic acid (Xia *et al.*, 1999). Although the number of reduced S sites may be limited, with low Hg concentrations, the strong affinity of Hg for S probably makes these sites the primary adsorption sites for Hg. When Hg is present at contaminated levels, the reduced S sites may become saturated and other reactions will take place, changing the apparent behavior of Hg with respect to organic matter.

The adsorption of Hg depends on several factors. In the following subsections, the effects of soil pH, organic matter, and particle size on the adsorption of Hg will be discussed. It is important to keep in mind that those factors that reduce the adsorption ability of Hg also tend to increase the solubility of Hg.

Soil pH

Soil pH is one of the most important factors determining metal distribution between solid and liquid phases. Most cations tend to become more soluble at low pH, and in areas affected by acid rain, nutrients like calcium are being leached from the soil at a higher rate than usual. It is generally thought that Hg differs from other metals in this respect because the strong affinity of Hg to organic matter means that it may become more mobile at higher pH levels as organic acids dissolve under higher pH conditions (Yin *et al.*, 1996). Increasing pH usually causes immobilization of cations, particularly hydrolysable metals, by sorption to solid surfaces or precipitation (Ledin *et al.*, 1996).

Studies that have used field and laboratory soils to conduct Hg studies under different pH levels have had varied results (Thanabalasingam and Pickering, 1985; Barrow and Cox, 1992a; Barrow and Cox, 1992b; Arnfalk *et al.*, 1996; Yin *et al.*, 1996). Yin *et al.* (1996) investigated the Hg adsorption behavior of 15 different New Jersey soils by adding laboratory solutions of $Hg(NO_3)_2$ to soil suspensions held at different pH levels. At low pH, Hg^{2+} was strongly adsorbed by all soils. The maximum adsorption occurred between pH 3 and 5 for all soils and ranged from 86 to 98% depending on soil type. Thanabalasingam and Pickering (1985) used laboratory-derived humic acids to observe adsorption with Hg solutions. The amount of Hg^{2+} adsorbed varied with pH, and peaked at a pH of 4.5. At pH levels below 4.5, adsorption decreased due to competition with H^+ ions for complexation sites.

Organic Matter

As mentioned previously, organic matter has a great capacity for binding Hg. Accumulation of Hg is related to organic carbon and sulfur levels in soil, and for this reason organic soils tend to have greater concentrations of Hg than do mineral soils (Schuster, 1991; Kabata-Pendias and Pendias, 1992; McBride, 1994).

Dmytriw *et al.* (1995) studied four soils in Quebec (a forest Spodosol, a flooded forest Spodosol, a gleysol, and pre-impoundment lake sediment now part of a reservoir) and observed that Hg was predominantly associated with the distribution of organic carbon in all four profiles. Andersson (1979) also noted that in a beech forest with podzolic soils ranging in pH from 3.9 to

4.7, organic material dominated the retention of Hg. These studies may reflect conditions present in the forested areas of Vermont where Spodosols are common.

Thanabalasingam and Pickering (1985) used laboratory-derived humic acids to observe adsorption of Hg in solutions. The affinity between active sites on the substrate and Hg was extremely high: more than 98% of the initial Hg in solution was sorbed by the organic materials. When the authors added 1 M HNO_3, only about half of the sorbed Hg was displaced, therefore, they concluded that much of the Hg was strongly bonded to the organic matrix. They also proposed that the reactive sites on the organic substrates were the functional groups that contain sulfur and nitrogen (carbon functional groups were not mentioned).

The bonding strength of metal ions onto humic or fulvic acids has been measured in several studies, and Hg has been shown to be one of the strongest to bind organic acids, with an order approximately as follows (Förstner and Wittman, 1981; Takamatsu *et al.*, 1983):

$$Hg^{2+} > Cu^{2+} > Pb^{2+} > Zn^{2+} > Ni^{2+} > Co^{2+} = Cd^{2+} > Mn^{2+}$$

Kerndorff and Schnitzer (1980) used laboratory-derived humic acids to observe the adsorption of Hg(II), Fe(III), Pb, Cu, Al, Ni, Cr(III), Cd, Zn, Co, and Mn in solution. The authors used all cations in the same solution to mimic natural field conditions. At all pH levels (2.4, 3.7, 4.7, and 5.8), Hg adsorbed more than other cations. In addition, Hg appeared to be bound more tightly than other heavy metals; it could not be displaced by them, especially when metal concentrations were very low. This is additional evidence for non-carboxylic binding of Hg to humic acids. At low concentrations, reduced S groups have not been saturated and can bond with all available Hg ions. Other trace metals that do not tend to bind with S will not be in competition for these sites.

Particle Size and Surface Area

Adsorption of Hg increases with decreasing particle size and increasing surface area (Andersson, 1979). The rank of importance to Hg sorption is as follows: surface area > organic content > cation exchange capacity > grain size (Schuster, 1991). Yin *et al.* (1996) used regression to predict the adsorption rate of Hg at a fixed pH of 4. Surface area, the aluminum concentration, and organic matter content were the most significant predictors of Hg adsorption. Of the soils in their study with low organic content, a soil with more silt and clay than other soils tended to adsorb more Hg^{2+}. This observation supports the hypothesis that increased surface area (silt and clay > sand) contributes to higher adsorption rates of Hg.

Mercury in the Soil Solution

The strong bond between Hg and soil constituents generally means that interactions between Hg cations and soil particles are strong enough to limit their availability to plants and animals and that only minute quantities are leached into water systems (McBride, 1994). Knowledge about the speciation and transformation reactions affecting the equilibria between the soil solution and solid phases is necessary in order to explain the retention and mobility of Hg in soils.

General statements about the mobility of Hg are difficult to make because of the complicated chemistry of Hg (McBride, 1994). According to Schuster (1991), the lower the concentration of heavy metals in the soil, the more sites there are available for high affinity adsorption, and the more likely it is that adsorption/desorption processes will determine the concentration of elements in solution. The parameters that affect chemical transformations of Hg in the soil solution have been identified as the redox potential, pH, and Cl concentration (Stiennes, 1990). These factors, in turn, can affect the adsorption and desorption processes that Schuster described. Transformations may also be mediated by microbial activity (Stiennes, 1990).

The dominant species of Hg^{2+} in solution are uncharged complexes (Schuster, 1991). Organic Hg complexes may be more prevalent than inorganic complexes in the soil solution (Andersson, 1979). The most common inorganic complexes formed in the field are probably compounds with chlorine (Arnfalk *et al.*, 1996; Yin *et al.*, 1996). Organic complexes with Hg are formed with particulate organic matter in the soil matrix (as described in the previous subsection) and dissolved organic ligands. Apparently mercury's affinity to dissolved organic ligands is so strong that the presence of organic matter in solution has been reported to inhibit the adsorption of Hg^{2+} on mineral surfaces (Schuster, 1991).

There is some disagreement about the relative contribution of dissolved Hg in natural waters. Thanabalasingam and Pickering (1985) noted that with Hg equilibrium constants favoring the solid phase, the transport of Hg in stream water would mainly be associated with suspended colloidal particles. Research in Minnesota appears to support this conclusion, with the concentration of Hg in streams having a stronger correlation with particulate organic carbon (POC) than DOC or total organic carbon (TOC) (Kolka, 1996). On the other hand, Yin *et al.* (1996) cited a study that concluded that most of the Hg in river water may be present as complexes with dissolved organic matter. Kabata-Pendias and Pendias (1992) also cited several Swedish studies which demonstrated that relative mobility of Hg in dissolved form was fairly high. In these studies, Hg appeared to be leached from acidic soil profiles in a form bound to organic compounds. In neutral and slightly alkaline soils, Hg was leached out in association with inorganic fractions. The largest amounts of Hg were found to be transported in autumn and spring, when water was more acidic and discharge was high.

The solubility of humic acids decreases at low pH. In solutions with a pH between 6 and 8, metals will most likely move with dissolved organic matter, and the organic matter will prevent precipitation of Hg as hydroxides (Schuster, 1991). In acid waters, such as those found in organic carbon-rich forest soils, metals should be drawn downwards along with the transport of organic matter and then trapped in the horizon where organic matter is immobilized (Schuster, 1991). For this reason, in temperate climates, organic soil horizons are thought to have higher concentrations of Hg in soil solutions than in lower soil horizons.

Collecting Soil Solution for Mercury Analysis

The soil solution is defined as the aqueous phase of soil and its solutes (Sparks, 1995). Many different techniques are used to collect soil solutions, but none of them obtain a soil solution truly representative of its relationship in dynamic equilibrium with plant roots, microorganisms, or solid phases of the soil. In addition, the chemistry of solution collected from macropores may be very different from the chemistry of water tightly held to the same soil during dry spells. Nevertheless, each collected sample represents a condition present in the soil solution at a given moment.

Because different methods for sampling soil solution tend to yield different chemical results, the best method to use frequently depends on the purpose of a particular study. For this study, I wanted to collect water moving through the soil horizons. I could also use only certain materials for sampling because ultra-clean laboratory methods are required for analyzing trace levels of Hg.

Several other studies have reported collecting soil solutions for Hg analysis. Table 2 presents Hg concentrations in soil water as reported in the literature. Aastrup *et al.* (1991) used ceramic suction lysimeters and Teflon suction samplers to collect soil water in a Spodosol in

South Central Sweden. They reported that the Teflon samplers yielded higher Hg levels than porcelain, with the difference being attributed to the larger pore size of the holes in the Teflon (3 μm in Teflon; 1 μm in porcelain). Porcelain is also a surface that Hg adheres to; therefore, it is likely that more Hg in the soil solution was adsorbed by the porcelain lysimeters than the Teflon ones. Lee *et al.* (1994) used suction lysimeters made with Prenart PTFE with a pore size of 5 μm in a study in western Sweden. They described the lysimeters as having an inert character and good hydraulic conductivity. Kolka (1996) used a zero tension steel box connected to a PVC pipe, stainless steel bucket, and polyethylene collection tank to obtain soil solution from below the organic O and inorganic Bt horizons in Minnesota soils. Because steel is not typically recommended for use in collecting trace levels of Hg, I think the results of this study are questionable.

Bishop *et al.* (1995) collected soil solutions from the Svartberget Catchment in northern Sweden. They collected soils from soil profiles and centrifuged 100 g portions of mineral soil in a polyethylene holder for 1 hour. Centrifugation was used to collect soil solutions because there is less risk of altering the sample through contact with a lysimeter surface or during storage in the lysimeter. However, the authors noted that TOC concentrations from centrifuged soil solutions tend to be higher than those in samples from lysimeters.

The technique of extracting water from bulk soil samples or soil cores by centrifugation or chemical means of separation was not used in this study because these methods yield water samples that represent the solute concentration in micropores and macropores (Boll *et al.*, 1992), but not necessarily the concentrations in bulk flow. Many methods that use bulk soil samples require air-drying and re-wetting soil, and this method alters the chemistry of the collected solution sample (Lawrence and David, 1996). Finally, with bulk extraction of soils, multiple samples cannot be taken from the same location in the field.

Ross and Bartlett (1990) have developed a syringe-pressure technique for soil solution extraction that squeezes water out of soil. This technique allows for chemical analysis of the bulk soil from which the soil solution came, and can give an accurate representation of the soil water moving through soil horizons (Ross *et al.*, 1994), but may alter solution chemistry by disturbing the soil (Ross and Bartlett, 1996). The volume of water obtained from this method was too small to be considered for work with Hg (60 mL of packed soil yields 4 to 10 mL of solution). A volume of more than 100 mL is desired for Hg analysis.

Tension (or suction) lysimeters also extract tightly-bound water contained in small soil pores (Swistock *et al.*, 1990), and therefore tend to collect higher concentrations of soil constituents. Tension lysimeters are said to collect solution that has interacted more closely with the soil than zero tension lysimeters (ZTLs) (Lawrence and David, 1996). ZTLs collect solution that moves downward through the soil by force of gravity, often through macropores. This method is therefore believed to be representative of soil water that is actually moving through the soil. One possible drawback is that they require that the soil above the samplers be saturated in order to collect a sample (Boll *et al.*, 1992). Installation of lysimeters disturbs soil, but it is generally assumed that the soil will recover to pre-installation conditions, although the length of time required is not well documented (Lawrence and David, 1996).

A new technique to sample water and solutes moving through the unsaturated layers in soil uses fiberglass wicks to create capillary suction (Holder *et al.*, 1991; Boll *et al.*, 1992; Poletika *et al.*, 1992; Brandi-Dohrn *et al.*, 1996; Knutson and Selker, 1996). The wick is self-priming and acts as a hanging water column, making it possible to draw samples from unsaturated soil without external application of suction (Boll *et al.*, 1992). There is evidence that the wick method collects water representative of that which moves through the soil profile, whereas suction cup samplers collect a solution that contains constituents more firmly bound to the soil matrix (Brandi-Dohrn *et al.*, 1996). A fiberglass wick collector was chosen to collect soil solution in this study. The collector was custom-made and was tested in the field and compared with the performance of a glass funnel ZTL. The first article in this thesis describes testing that I completed to assess whether the wick would collect enough water and to see whether the Hg content was significantly altered by the wick.

TRANSPORT OF MERCURY TO STREAMS

The previous section discussed Hg in soils. We will now explore the transport of Hg from soils to the streams. This section will also examine the relationship between Hg and organic carbon because several studies have shown that in terrestrial ecosystems, the concentration of Hg in soil water and lake water is highly correlated with the concentration of humic matter. The section concludes with a brief summary of methods used for assessing the concentration of humic matter in natural waters.

The Connection Between Soil Water and Stream Water

First it is important to identify some of the sources of water in streams. Groundwater supplies base flow to streams. Base flow carries solutes downstream from chemical weathering of bedrock and soils and decomposition of organic matter (Lindberg and Turner, 1988). During storms, streamflow is comprised of varying proportions of base runoff, subsurface stormflow, overland flow, and direct precipitation. Subsurface stormflow is runoff derived from subsurface flow paths that arrives quickly enough to become part of the stream discharge associated with a storm. Overland flow is the flow of rainwater or snowmelt over the land surface towards stream channels. The latter sources of water, along with precipitation, tend to carry soluble and particulate forms of metals that are directly and indirectly derived from the atmosphere. In undisturbed forests of humid temperate climates, subsurface stormflow is the dominant contributor to streams unless the soil becomes saturated to the surface. Saturated overland flow is of limited extent except at the base of the slope and during spring snowmelt (Bonell, 1993).

A large proportion of soil water and Hg entering streams has passed through deeper soil layers and is comparatively "old" (Meili, 1991a). Isotopic analyses have demonstrated that stream water is nearly always dominated by pre-event, or "old," water rather than by event, or "new," water. Some studies have shown that this pre-event water reaching the channel during a storm event may be supplied from a fairly localized near-stream zone (Buttle, 1994). The contribution of pre-event water during periods of high runoff may be explained by the groundwater ridging mechanism: infiltration of storm water can raise the water table thereby increasing the hydraulic gradient to the stream and enhancing the flux from groundwater to the stream. Translatory flow is another mechanism that explains the contribution of pre-event water to stream flow. According to this theory, "new" precipitation inputs cause lateral throughflow of "old" rainwater or snowmelt that was stored in the soil. This old water is displaced by the new precipitation and released to channel flow (Buttle, 1994).

Macropore flow may also be significant in the delivery of water from soils to streams. Event water infiltrates to a bedrock surface and at the top of this surface a transient perched aquifer forms. The water from this transient aquifer has a pre-event chemical signature and is rapidly drained down slope through a macropore network and eventually discharged to the stream (Buttle, 1994).

Isotope studies that show stormflow dominated by "old" water unfortunately group soil water and groundwater contributions together, masking the individual importance of either component. DeWalle *et al.* (1988) used a three component ^{18}O tracer model to estimate the

individual contributions to stormflow from groundwater, soil water, and direct precipitation into the stream channel based on $^{18}O/^{16}O$ ratios of the three source waters. The study took place at Laurel Hill in southwestern Pennsylvania during the months of October and November in 1986. Analysis of individual rain events suggest that total storm runoff was composed of 6 to 40% soil water. Contributions from direct precipitation never surpassed 14% and groundwater accounted for the remaining flow. The relative contribution of soil water increased as antecedent soil moisture increased. The results of this study suggest that soil water can at times be a major contributor to stormflow, but the short duration of the study makes it impossible to draw conclusions about the year-round conditions in other streams, such as those in the Champlain valley of Vermont.

Several other studies have identified a chemical connection between soils and streams. In their summary of the literature, Reuter and Perdue (1977) noted that the striking similarity between soil humic substances and aquatic humics implies a soil origin for at least part of aquatic humic matter. They specified that the main fraction of dissolved humic substances in river waters closely resembled soil fulvic acids. In several southeastern U.S. coastal plain streams, organic carbon concentrations increased when discharge increased and decreased during periods of low discharge. This trend suggests that the bulk of organic carbon, and specifically humic substances, is derived from the soil after the water level has risen up through the profile during rain storms and overland flow becomes a significant contributor to total runoff (Reuter and Perdue, 1977).

Other studies have demonstrated a link between soil water and stream water chemistry using correlation between major ion concentrations. Ross *et al.* (1994) extracted soil solutions from fresh soil horizon samples on the western side of Camel's Hump in Vermont. In one watershed, B horizon water was the dominant contributor to stream chemistry. In another watershed, both seep water and non-seep B-horizon water were contributors. McDowell and Likens (1988) observed that the organic chemistry of stream water at Hubbard Brook, New Hampshire was similar to that of the B horizon soil solution. They noted that most DOC lost from the forest floor in soil solution is translocated to the B horizon and never enters the stream. During spring runoff, however, increased lateral flow through the upper B horizon would result in an increase in the DOC of soil water entering the stream.

Similar to the conclusions of Ross *et al.* (1994) and McDowell and Likens (1988), David *et al.* (1992) proposed that the quality and quantity of DOC fractions in streams and lakes of central Maine were strongly related to contact with soil leachates in the B horizons. David *et al.* (1992) also observed that during large storm events, stream DOC increased. They hypothesized that the increase of DOC during storms may occur because high-DOC water from the forest floor does not have a chance to percolate downward and adsorb to solid particles in the lower soil horizons. Most DOC loss and water export occurs in March, April, and May, with additional export occurring in October and November of wet autumns (David *et al.*, 1992).

Water flow paths control the chemistry of waters draining a forested catchment. This subsection has demonstrated that forest soils can influence the chemistry of streams. The next subsection discusses the relationship between Hg and organic carbon in natural waters.

Hg and Organic Carbon in Natural Waters

The affinity of Hg for organic matter holds true in rivers and streams in addition to soils. Many researchers have concluded that the transport of Hg in freshwater systems is related to the transport of humic and fulvic acids. However, it is difficult to predict the chemical behavior of Hg in natural waters because at trace levels, microchemical phenomena and secondary reactions are important but not well understood.

In general, the majority of humic substances in small streams are of allochthonous origin from soil and plant matter. Only a minor amount of DOC reaches streams via groundwater discharge (Thurman, 1985). In natural waters, much of the dissolved organic matter is composed of aquatic fulvic acids. Fulvic acids tend to occur in a dissolved state and have a smaller molecular mass (less than 700) than humins or humic acids. They play an especially important role in bonding metals because of their numerous functional groups and solubility. Fulvic acids bond particularly well with divalent metal ions to form complexes (Thurman, 1985; Chin *et al.*, 1994).

It is difficult to characterize the exact relationship with fulvic acid because Hg^{2+} hydrolyzes and there are many possible fulvic acid chelating sites. Earlier research assumed that Hg^{2+} chelates with fulvic acid at the salicylic acid-like bidentate structure of fulvic acid, a site at which Cu^{2+} is known to chelate (Cheam and Gamble, 1974). X-ray absorption spectroscopy has recently revealed that reduced sulfur functional groups (thiol and disulfide/disulfane) and to a lesser extent carboxyl and phenol ligands are involved in the complexation of Hg^{2+} to humic substances (Xia *et al.*, 1999). Hintelmann *et al.* (1995) looked at the stability constants of methyl-Hg associations with humic and fulvic acids from Fawa Lake in Ontario. Based on the high binding capacities they found, they assumed that CH_3Hg^+ is bound to sulfidic binding sites (Hintelmann *et al.*, 1995).

Several recent studies have shown a correlation between Hg and organic carbon without identifying the exact relationship. Mierle and Ingram (1991) measured total Hg concentration in eight inflowing brownwater streams from two headwater lakes and catchments in Ontario over a two-year period. They found that over 95% of the variation in the export of Hg was explainable by the color of the water. They measured organic carbon content by analyzing water color and DOC concentrations. Color and DOC were correlated but there were systematic seasonal differences between the two. The difference between color and DOC will be discussed in the next subsection.

Johansson *et al.* (1991) drew a connection between Swedish soils and streams by showing that, per unit of organic carbon, the Hg in soils is roughly equivalent to the Hg in streams within the same catchment. The authors concluded that in these catchments, transport of Hg is mainly controlled by Hg content in the soils and the humic matter content of stream waters. On the other hand, Swain *et al.* (1992) refuted the idea that the terrestrial export of Hg to lake basins may be controlled by the nature of catchment soils and the movement of organic acids. They studied whole-basin Hg fluxes in several lakes in Minnesota and Wisconsin and showed that the relative size of the catchment controls the humic content of a lake in a given bioregion. Different soil types did not affect Hg fluxes among the study watersheds.

Most studies of metal-fulvic acid interactions have concentrated on characterization of dissolved complexes, but other mechanisms of interaction may be important. For example, trace metals are readily adsorbed on the surface of particulate humic substances (Reuter and Perdue, 1977). A recent study in Minnesota indicates that total Hg concentrations in forest soil runoff and streamflow are most closely related to POC (measured as the difference between TOC and DOC) (Kolka, 1996). Balogh *et al.* (1997) analyzed water samples collected from different locations in the lower Minnesota River in southeast Minnesota and found that Hg and suspended sediment loadings are primarily determined by runoff-driven sediment inputs from upstream tributaries. The land use in the Minnesota River watershed was 92% agricultural. They found that 98% of the annual Hg load was carried between March and November. During high runoff periods, total Hg and total suspended solids increased. The fraction of soluble Hg (passing through a 0.4-μm filter) decreased while the fraction of particulate Hg increased. They concluded that suspended sediment sources in the watershed are also sources of Hg; therefore, land use practices that reduce stream bank erosion and soil erosion from croplands should reduce Hg loadings into the lower Minnesota River (Balogh *et al.*, 1997).

Measurement of Organic Carbon in Natural Waters

Measuring DOC and color are two ways of assessing the amount of dissolved organic materials present in natural waters. Both methods have been used by researchers studying trace levels of Hg. In this thesis, concentrations of DOC and color were determined in order to compare results with all studies.

DOC is generally defined as the organic carbon that passes through a 0.45 μm filter. The boundary between DOC and POC (the difference between TOC and DOC) is somewhat arbitrary and there are no major differences in their physical and chemical properties as far as metal complexation is concerned (Reuter and Perdue, 1977). DOC is measured in the laboratory by converting all organic matter in solution to CO_2 and then measuring this CO_2 (Drever, 1988). The composition of DOC in natural waters varies, but a generalized breakdown of DOC is as follows: 50% is aquatic fulvic and humic acids, 30% is other hydrophilic acids (including low molecular weight organic acids), 10% is carbohydrates, 7% is carboxylic acids, 3% is amino acids, and less than 1% is hydrocarbons (Thurman, 1985). The DOC concentration does not represent a measurement of all organic material in the water, but it is a major fraction of the organic carbon transported in streams (David *et al.*, 1992) -- in Bear Brook, NH, 47% of organic carbon was transported in dissolved form (Tate and Meyer, 1983). Table 3 presents DOC concentrations in natural waters from several different studies.

Color of humic substances is linearly related to the concentration of humic matter in natural waters and for this reason color is commonly used to measure the concentration of humic matter in streams and rivers (Thurman, 1985). In their study of total Hg in lakes in Ontario, Mierle and Ingram (1991) measured both DOC and color. Color was measured by a colorimetric method that compared the absorbence of water samples to a set of platinum cobalt standard solutions. They found that although color and DOC were correlated, there were systematic differences between the two. The authors suggested that color is probably a measure of humic and fulvic matter in waters, whereas DOC measures all types of carbon (humic and fulvic acids as well as carbohydrates, proteins, and other organic compounds). Because more than 95% of the variation in the export of Hg was explainable in terms of the export of color, the authors suggested an intimate link between humic matter and the concentration of Hg in streams. Meili (1991) and Lee and Iverfeldt (1991) also measured color in Swedish lakes and found positive correlation between Hg and color.

Table 1. Mercury concentrations (dry weight) in soils.

Soil depth	Concentration (ave. or range) µg g^{-1}	Location	Reference
Mor layer upper B horizon lower B horizon	0.250 0.058 0.023	Tiveden National Park, South Central Sweden	(Aastrup *et al.*, 1991)
Organic layer 0-10 cm 10-50 cm	0.143 0.036 0.011	Cedar Creek Natural History Area, East Central MN	(Grigal *et al.*, 1994)
Forest floor Mineral soil	0.12–0.18 0.021–0.03	Several sites in MN, WI, and MI	(Nater and Grigal, 1992)
Humus 5 cm 17.5 cm 30 cm	0.22 0.244 0.160 0.155	Wallace Falls, Cascade Mountains, WA	(Lindqvist, 1991)
2 cm 5 cm 10 cm 20 cm	0.70 0.60 0.15 0.10	150 km northeast of Cologne, Germany	(Padberg and Stoeppler, 1991)
Litter horizon 0-2 cm (organic) 2-5 cm (mineral) 20-25 cm (mineral)	100 680 500 150	Walker Branch Watershed, Oak Ridge, TN (*nearby industrial source of Hg*)	(Lindberg, 1996)
6-10 cm (Oa horizon) 22-28 cm (B horizon)	0.195 0.063	Underhill Center, VT	This study
	0.4–0.5	Proposed Swiss guideline for health of soil microbiology	(Johansson *et al.*, 1991)

Table 2. Mercury concentrations in soil solutions.

Soil depth	Concentration (mean or range)	Collection method	Location	Reference
	ng L^{-1}			
0-8 cm	11.9	Ceramic suction lysimeter	Tiveden National Park, South Central Sweden	(Aastrup *et al.*, 1991)
8-20 cm	13.6			
20-50 cm	15.1			
5 cm	12–70	Centrifugation	Svartberget Catchment, Sweden	(Bishop *et al.*, 1995)
25 cm	3–15			
below the O horizon	25.5†, 29.17†	Steel box zero-tension lysimeter	Two watersheds, MN	(Kolka, 1996)
top of Bt horizon	20.22†, 15.03†			
5 cm	4.91 4.79†	Tension lysimeter	Walker Branch Watershed, Oak Ridge, TN	(Lindberg, 1996)
6-10 cm	1.1–34.9	Fiberglass wick collector	Underhill Center, VT	This study
22-28 cm	0.1–10.2			

† Volume-weighted mean

Table 3. Dissolved organic carbon in natural waters.

Water source	Concentration (mean or range)	Location	Reference
	mg L^{-1}		
precipitation	1.09†	Hubbard Brook Experimental Forest, NH	(McDowell and Likens, 1988)
throughfall	11.95†, 33.9		
E horizon	28.0†, 37.5†		
upper B horizon	5.91†		
B horizon (30 cm)	2.96†		
seeps	1.73		
Bear Brook	3.13†, 1.82†		
groundwater	0.6–2.2	Allequash Creek, WI	(Krabbenhoft *et al.*, 1995)
wetland streams	2.8–7.8		
lower basin streams	4.1–7.4		
surface runoff (shallow soil water)	23.35†, 20.28†	Two watersheds, MN	(Kolka, 1996)
subsurface runoff (deep soil water)	15.90†, 8.66†		
Oa horizon	1.0–36.1	Underhill Center, VT	This study
B horizon	0.3–16.7		
Nettle Brook weir	3.9		
Stream 10	4.4		

† Volume-weighted or flow-weighted mean

Passive Capillary Fiberglass Wick Sampler for Mercury Determinations in Soil Water

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ABSTRACT

There are many methods for collecting soil water and different methods can yield different chemical results. The best method for a particular study often depends on the purpose of that study. This article identifies a passive capillary fiberglass wick sampler used for analyzing trace levels of mercury (Hg) in soil water from an uncontaminated, forested watershed. A wick sampler has not previously been used for this application, and we completed several small pilot tests to examine its suitability. Laboratory tests compared the amount of Hg in water poured through the devices with the amount of Hg in control samples. The first laboratory test showed that the wick sampler adsorbed ~ 20% of the Hg compared to control samples. Two subsequent laboratory tests compared the amount of Hg and trace metals in water poured through the devices after they had spent 1-2 months in the field. Results from these tests were affected by soil present on the wick material after removal, but indicated that wick-to-wick variability was low and the samplers did not grossly affect the chemistry of a sample. In addition, the wick device is capable of collecting sufficient volumes of water while being small enough for use in a forested area with shallow bedrock.

INTRODUCTION

Currently there is concern about the level of mercury (Hg) in fish in Lake Champlain and in other, more remote lakes in northeastern North America. Elevated Hg levels in fish and ecosystems are attributed to decades of atmospheric deposition originating from emission sources. Studies indicate that much of the Hg in lakes comes from the watershed (Lindberg and Turner, 1988; Meili, 1991a; Lee *et al.*, 1994) and that the ratio of catchment to lake area can explain variation in the Hg accumulation in sediment in remote lakes (Swain *et al.*, 1992). The catchment-to-lake ratio for Lake Champlain is 19:1. Movement of Hg in forest soils may therefore play an important role in the loading of Hg into surface waters draining into Lake Champlain. In order to test hypotheses about Hg transport in catchments, it is necessary to examine the chemistry of soil water. Here we describe work completed to identify a suitable device with which to collect soil water for Hg and trace metal analysis.

There are numerous ways to obtain soil solution, and the chemistry of the soil solution varies depending on the means of extraction. Methods that collect soil solutions representative of water naturally moving through soil horizons are best for transport studies. Techniques that extract water from bulk soil samples or soil cores, for example, are not suitable because these methods yield water samples that represent the solute concentration in micropores and macropores (Boll *et al.*, 1992) and not necessarily the concentrations in bulk flow. Tension lysimeters also extract tightly-bound water contained in small soil pores (Swistock *et al.*, 1990) and so tend to collect higher concentrations of soil solutes. For Hg, the strict requirements of ultra-clean laboratory methods for analyzing trace concentrations also limited the possible materials usable for sampling.

Zero-tension lysimeters (ZTLs) were considered because they collect solution that moves downward through the soil by force of gravity, often through macropores. One drawback of these and other lysimeters is that their installation can disturb the overlying soil and root structures, but it is assumed that the soil eventually recovers to pre-installation conditions (Lawrence and David, 1996). ZTLs also require that the soil above the samplers be saturated to collect water (Boll *et al.*, 1992).

A new technique uses fiberglass wicks to collect water by capillary action (Holder *et al.*, 1991; Boll *et al.*, 1992; Poletika *et al.*, 1992; Brandi-Dohrn *et al.*, 1996; Knutson and Selker, 1996). The wick is self-priming and acts as a hanging water column, thus samples can be drawn from unsaturated soil without external application of suction (Boll *et al.*, 1992). Based on a study by Brandi-Dohrn *et al.* (1996), there is evidence that the wick device collects solute concentrations representative of water in motion through the soil profile.

We constructed several passive capillary wick samplers and conducted pilot tests in the field and laboratory to determine if these devices were clean enough to use in a trace metal study. Previous studies have indicated that the wick sampler has negligible effects on solute transport (for Br^-, NO_3^-, Cd, volatile organics, and Blue Dye No. 1) (Holder *et al.*, 1991; Knutson and Selker, 1996). However, the concentrations used in these studies (mg L^{-1} range for Cd for example) were much higher than what we expected in our study (ng L^{-1} for Hg and µg L^{-1} for other trace metals). We also require 75–100 mL soil solution for our analysis. Before beginning a larger field study on Mt. Mansfield, Vermont, we wanted to confirm that enough water could be collected with the wick samplers and that the Hg concentrations of our samples would not be drastically changed by passage through the wick material.

MATERIALS AND METHODS

Fiberglass wick samplers (Figure 1) were custom-made with a length of 3.8-cm diameter wick (braided medium-density 1.5-in diameter fiberglass wick, #10-863KR-10, Amatex Co., Norristown, PA) fit snugly inside Pyrex glass tubing (4 cm diameter x 30 cm length) and placed vertically within the soil. The glass tubing was flared out at the top to form a flat plate against which the top portion of the wick was unraveled, fanned out, and pressed. This part of the wick is in contact with the soil, and our devices were made with a sampling area of 170 cm^2 (14.7 cm plate diameter). Water flowing through the soil is intercepted by the plate, drawn into the wick, and conducted down through the glass column. Water drains into a sample bottle through Teflon tubing (based on Holder *et al.*, 1991). Prior to use, the fiberglass wick material and Pyrex glass were baked for 90 minutes at 425°C in a muffle furnace and then rinsed with low-Hg deionized water.

Adsorbence of Hg by fiberglass wick fibers has not yet been reported, but the possibility of adsorption onto or desorption from exchange sites was examined by comparing the chemistry of water passed through the wick collectors against control water.

In the laboratory, initial performance of the collectors was quantified by rinsing them with actual rainwater (pH ~ 4.5) composited from several storms. For each "rinse," 250 mL of rain water was poured through two clean fiberglass wick samplers at a rate of 10 mL every 4.5 minutes. The resulting samples were analyzed for Hg and compared against control samples of rainwater. We also speculated that ion exchange sites in the collectors (which might adsorb or desorb Hg) would become saturated over time. To examine this question, one fiberglass wick sampler was installed at our field site in Underhill Center, VT at a depth of 6 cm below ground surface for a period of one month (27 September to 27 October 1996). When removed, it was rinsed as above with rainwater and analyzed for Hg and other trace metals. The experiment was repeated the following year using three wick samplers which were buried for slightly more than two months (29 July to 6 October 1997). Stream water (pH ~ 7) was used as the rinse and control waters for this experiment. Each wick was first rinsed with approximately 1 L water to flush out soil material before collecting rinse samples.

Soil water samplers were installed in the field by digging pits approximately 90 cm x 60 cm x 75 cm deep and tunneling laterally into the upslope wall so that the soil water samplers could be placed under a given depth of undisturbed soil. After installation of the samplers, access holes were back-filled with moistened soil. Solutions drained from a Teflon tube into a partially buried plastic container where sample bottles were placed. Volumes of water collected by the samplers were measured after each rainstorm.

Our study site is a forested area on the western slope of Mt. Mansfield at an elevation of 550 m. Soils are Typic Haplorthods with a C horizon less than 1 m below the ground surface.

The laboratory portion of the experiments was conducted in a counter-top HEPA clean chamber to avoid trace Hg contamination. Particle-free gloves were worn at all times when collecting and handling samples. Samples were collected in triple-bagged, acid-washed Teflon bottles. Samples were shipped by overnight courier to the University of Michigan Air Quality Laboratory (UMAQL) in Ann Arbor, MI, where analysis for total Hg was performed using cold vapor fluorescence spectrometry in a Class 100 ultra-clean laboratory. Trace metals were analyzed using an inductively coupled plasma mass spectrometer (ICP-MS). Analytical and quality assurance details are given in Burke *et al.* (1995).

RESULTS AND CONCLUSIONS

In the first laboratory experiment, the wick collector adsorbed approximately 20% of Hg present in control rainwater (Figure 2). This adsorbence rate indicated that the wicks did not grossly affect sample chemistry with respect to Hg.

In the second one-month field experiment, the first two rinses of the wick collector produced higher Hg concentrations than the control rainwater (Figure 2). Only the third rinse showed adsorption of Hg (~ 15%). It is likely that the elevated Hg in the first two rinses was the result of flushing soil material that had adhered to the collector following its removal from the field. This hypothesis is supported by the behavior of titanium (Ti), a crustal element that was barely present in rainwater but shows initially high and then declining concentrations in the wick rinses (Figure 2).

In the third experiment, three wick collectors were installed in the field for a little more than two months. Upon removal, soil again adhered to the wicks. Each wick was rinsed with approximately 1 L water to flush out soil material, however results of this experiment again show higher and declining Hg concentrations compared to control stream water (Figure 2), albeit with lower concentrations than in the second experiment. Titanium also exhibited this pattern. In the third experiment, wick-to-wick variability was low and was typically less than the variability in control samples. The control water used in the third experiment (stream water), with its higher pH and very likely higher organic carbon concentrations, may have caused Hg-organic carbon complexes to be mobilized off residual soil particles and flushed through the wicks.

The wick samplers buried just below the Oa horizon (5-10 cm) were typically able to collect samples in excess of 100 mL during storms that brought greater than 12 mm rainfall. Samplers buried within the B horizon (22-28 cm deep) generally needed more rainfall to collect sufficient volumes of water, and volumes collected varied greatly by site.

We believe that the disturbance of removing our devices influenced the laboratory experiments, but that if the residual soil effect is eliminated the results indicate that the non-tension fiberglass wick sampler is a suitable device for collecting soil water for Hg analysis. Once installed and allowed to equilibrate in the field, contributions from disturbed soil should be minimal. The wick sampler may adsorb as much as 20% Hg in soil solution, but this amount may decline over time once exchange sites on the fiberglass material are filled.

ACKNOWLEDGMENTS

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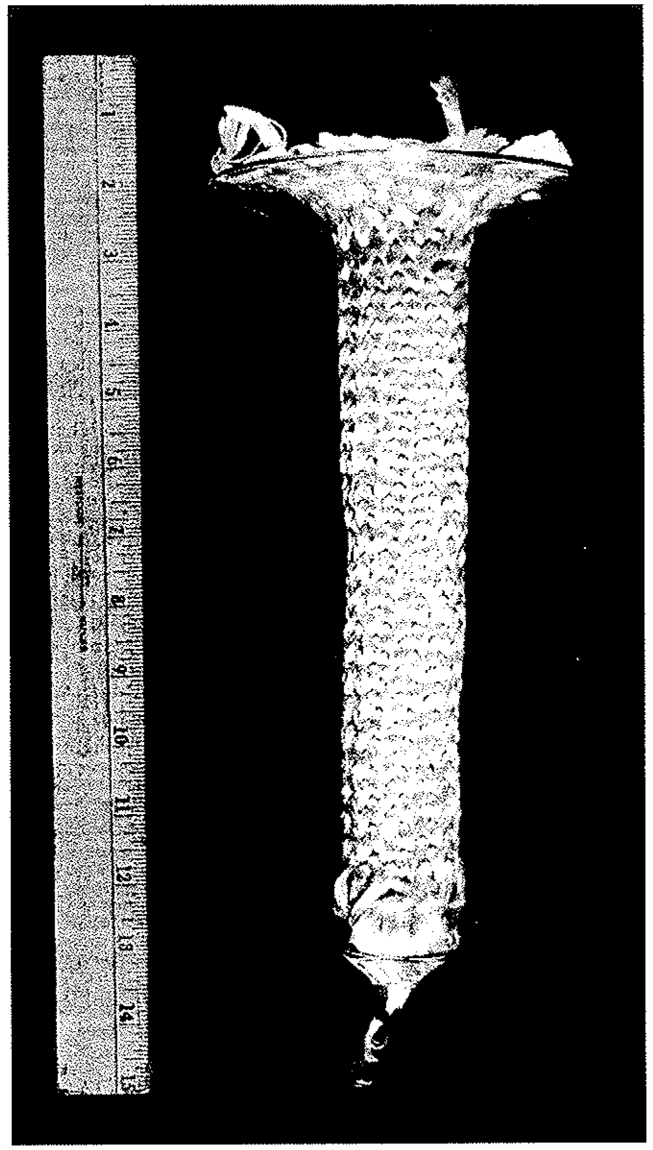

Figure 1. Fiberglass wick soil water collector. Ruler shown for scale is 38 cm (15 in).

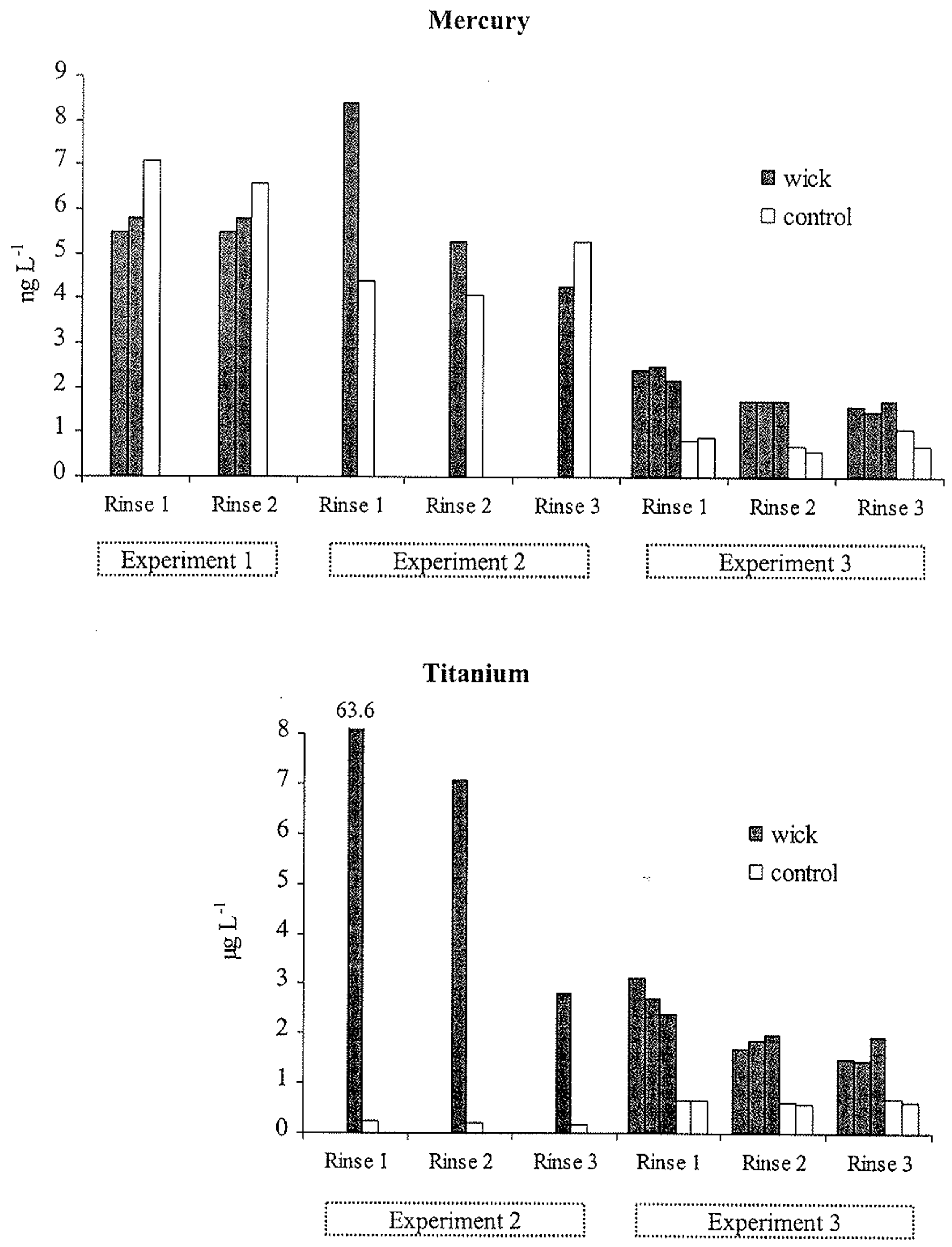

Figure 2. Concentrations of Hg and Ti in rinse water run through the fiberglass wick collector. Multiple bars of the same color represent replicates of the collectors or control water

TRANSPORT OF MERCURY FROM SOILS TO STREAMS IN TWO FORESTED CATCHMENTS ON MT. MANSFIELD, VERMONT

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Abstract. Soil solution and stream water from locations in two small forested catchments in Underhill Center, VT were analyzed for mercury (Hg), dissolved organic carbon (DOC), color, trace elements, and major ions. Samples were collected during snowmelt and rain events between April and November 1997. Mercury concentrations in Oa and B horizon soil water ranged from 1.1 to 34.9 ng L^{-1} and 0.1 to 10.2 ng L^{-1}, respectively. In streams, dissolved Hg was 0.9 to 4.1 ng L^{-1} and total (dissolved + particulate) Hg was 0.9 to 9.2 ng L^{-1}. Mercury and other trace metals were typically present in higher concentrations in soil water than streams, indicating additional removal of these elements below the sampling depths before reaching streams. In soil water and stream water, Hg was positively correlated with DOC and color. Mercury concentrations followed a pattern similar to other trace metals that form complexes with organic carbon, such as Al, Cr, Cu, and Pb. Most of the Hg in the streams is associated with particulate

matter, but the small and continual contribution of dissolved Hg from soil water and groundwater also exports significant amounts of Hg from these forested systems.

Key words: mercury, Hg, trace metals, DOC, soil, soil water, stream, catchment, forest.

1. INTRODUCTION

Mercury (Hg) contamination in freshwater fish is a widespread environmental problem throughout the northern hemisphere. In Vermont, Hg fish tissue concentrations above the U.S. Food and Drug Administration action level of 1 ppm in some species have caused the State to issue an advisory on fish consumption. Atmospheric sources of Hg are thought to be responsible for increasing Hg burdens in Lake Champlain (Watzin, 1992; Scherbatskoy *et al.*, 1997) but the sources and mechanisms of transport and accumulation are not well understood. In the Lake Champlain basin, more than 90% of the water entering the lake first passes through the 21,150 km^2 watershed (Lake Champlain Management Conference, 1996). Because of the large land-to-lake area ratio (19:1), with 64% of the land area forested (recent unpublished data, Vermont Center for Geographic Information, October 1998), the presence of Hg in forest soils likely influences the loading of Hg to the surface waters that drain into Lake Champlain.

Mercury in forest soils is strongly bound to soil constituents or revolatilized into the atmosphere and only a minor fraction is transported from the soils to surface waters. In a small forested catchment in Underhill Center, VT, dissolved Hg concentrations in stream water are consistently low (< 4 ng L^{-1}), but accounted for 26 and 38% of the total Hg exported in the stream during two years of study (Scherbatskoy *et al.*, 1998). Although Hg has also been shown to be primarily associated with suspended sediment in rivers and streams (Kolka, 1996; Balogh *et al.*, 1997; Scherbatskoy *et al.*, 1998), the small percentage of Hg mobilized from soils to streams may contribute 25–75% of Hg reaching lakes (Lee *et al.*, 1994).

In dissolved and particulate form, the transport of Hg is closely related to the transport of organic matter (Mierle and Ingram, 1991; Pettersson *et al.*, 1995). The Hg in soils (as Hg^{2+}) is associated with humic matter, most likely with fulvic acids. In the soil solution, the dominant species of Hg^{2+} are uncharged complexes (Schuster, 1991), with organic Hg complexes more prevalent than inorganic complexes (Andersson, 1979). X-ray absorption spectroscopy has revealed that reduced sulfur functional groups (thiol and disulfide/disulfane) and to a lesser extent carboxyl and phenol ligands are involved in the complexation of Hg^{2+} to humic substances (Xia *et al.*, 1999). Other major ions and trace metals (e.g., Al, Cu, Cr, Fe, Pb) are also known to form stable complexes with dissolved organic acids and are transported through the soil in complexed form (Tyler, 1978; Bergkvist, 1987), but Hg has one of the strongest affinities for organic compounds compared to other elements, in the approximate order of $Hg^{2+} > Cu^{2+} > Pb^{2+} > Zn^{2+} > Ni^{2+} > Co^{2+} = Cd^{2+} > Mn^{2+}$ (Cheam and Gamble, 1974; Förstner and Wittman, 1981; Takamatsu *et al.*, 1983). Given the strong relationship between Hg and organic acids, adsorption and desorption reactions of organic matter in soils will strongly affect the mobilization and transport of Hg to streams.

The objectives of this work were to: (i) determine the concentrations of Hg, dissolved organic carbon (DOC), and several trace metals in soil and stream solutions in two small catchments in the Lake Champlain basin, (ii) compare the behavior of Hg with DOC and trace metals in these media, and (iii) use the results to identify factors that might affect the transport of dissolved Hg in an upland catchment.

2. MATERIALS AND METHODS

2.1 SITE CHARACTERISTICS

This study focuses on two small catchments on the western slope of Mt. Mansfield in Underhill Center, VT (Figure 1). The sites are centrally located in the Lake Champlain basin, approximately 31 km northeast of Burlington, VT and 120 km south-southeast of Montréal, PQ. Both sites lie within the Lamoille River watershed. Nettle Brook is a small stream draining an 11-ha mixed hardwoods catchment between 445 and 664 m elevation. The stream originates on a wet hillslope, levels at a boggy area, and descends steadily until it discharges into Stevensville Brook. Since October 1993, water samples have been collected for Hg and major ions at a continuously gauged v-notch weir at 445 m elevation. Water flows out of the weir year-round, but the upper parts of the stream often become dry during the summer. Stream 10 is a small stream draining a 7.4-ha mixed conifer and hardwoods catchment between 775 and 1180 m elevation. The stream originates near the "nose" portion of the summit ridge of Mt. Mansfield and descends steeply down the west face. Water samples have been collected here since March 1995, at a point just upstream of a culvert under the CCC Road in Underhill State Park. Stream flow at the culvert ceases during dry periods even when the stream is flowing at higher elevations. The portion of the stream that includes the lower half of Mt. Mansfield has not been studied.

The study sites are underlain by mica-albite-quartz schist bedrock. The surficial geology is dominated by a cover of glacial till deposited in the late Wisconsinan age (Connally, 1968). Soils developed at the study sites are Typic (Nettle) and Cryic (Stream 10) Haplorthods. These soils were originally mapped as the Peru extremely stony loam series in the Chittenden County Soil Survey.

At the Nettle Brook sites, the forest is dominated by sugar maple (*Acer saccharum* Marsh.), striped maple (*Acer pensylvanicum* L.), yellow birch (*Betula alleghaniensis* Britton), and American beech (*Fagus grandifola* Ehrh.). The hardwoods in this catchment have been intensively used for lumber production for about 150 years, with the last 70 years under state ownership (Cogbill, 1995). At the Stream 10 site, the forest is composed of American mountain ash (*Sorbus americana* Marsh.), yellow birch (*Betula alleghaniensis* Britton), red spruce (*Picea rubens* Sarg.), balsam fir (*Abies balsamea* (L.) Mill.), American beech (*Fagus grandifola* Ehrh.), and striped maple (*Acer pensylvanicum* L.). This area has been owned by the state of Vermont since 1929 and is currently designated as a natural area with no plans for logging in the near future.

The Nettle Brook and Stream 10 sites are both located within 3 km of the Vermont Monitoring Cooperative (VMC) air quality monitoring site located at Proctor Maple Research Center (PMRC) (400 m elevation) in Underhill Center, VT. Mercury concentrations in precipitation, vapor, and particulate samples are continuously monitored at this site, as are ambient and within-forest meteorology, ozone levels, wet and dry deposition, and particulate trace metal concentrations. Average rainfall is 1100 mm yr^{-1}. Rainfall during the sampling period of this study, 20 Apr.–3 Nov. 1997 was 675 mm, with a maximum daily rainfall of 45.3 mm occurring on 9 July.

Anthropogenic inputs of Hg to the forest floor come in wet precipitation, dry deposition, throughfall, and litterfall. Wet deposition of Hg at the PMRC monitoring site averages 87 mg ha^{-1} yr^{-1} (Scherbatskoy *et al.*, in press). Dry deposition of Hg vapor to the forest ecosystem is large during the warmer months, perhaps five times that of wet deposition (Scherbatskoy *et al.*, 1998), but it is difficult to accurately estimate the dry deposition rate because of large uncertainties in the re-emission of Hg from forests (Scherbatskoy *et al.*, in press). During the

study period 20 Apr.–3 Nov. 1997, Hg in precipitation at PMRC ranged from 1.2 to 53.1 ng L^{-1}, with an average (± std. dev.) of 13.4 ± 9.8 ng L^{-1}. Throughfall Hg was measured during August and September 1994 at PMRC (Rea *et al.*, 1996). At that time, the mean volume-weighted throughfall concentration of Hg was 12.0 ± 8.5 ng L^{-1} (range 4.5-35.8 ng L^{-1}), and the yearly throughfall deposition to all forested areas of the Lake Champlain basin was estimated to be 117 mg ha^{-1}. Yearly deposition of Hg via litterfall in 1994 was 130 mg ha^{-1}, making a total annual below-canopy Hg deposition of 247 mg ha^{-1}.

2.2 FIELD SAMPLING TECHNIQUES

Passive capillary wick soil water samplers were custom made based on designs described in Holder *et al.*, (1991); Knutson *et al.*, (1993); and Knutson and Selker (1996). The samplers (see Figure 1 of the first article in this thesis) were made of 30 cm long x 4 cm diameter Pyrex glass tubing and 3.8-cm diameter wick (fiberglass medium-density 1.5-in diameter knitted rope, #10-863KR-10, Amatex Co., Norristown, PA). The glass tubing flares out at the top end to form a flat plate (diameter 14.7 cm), and the wick fits inside the tubing with the top portion unraveled and pressed flat on the plate. The flat top comes in contact with the soil; the 170 cm^2 area of the plate is the sampling area. Water flowing through the soil is intercepted by the plate, drawn into the wick, and conducted down the glass column through an 11-mm glass fitting at the bottom. Soil solution drains into a 500-mL Teflon bottle via 11-mm inner diameter (i.d.) Teflon tubing (Nalgene) and segments of 12.8-mm i.d. C-flex tubing (Cole-Parmer) fitted through drilled holes in the bottle caps. The C-flex tubing and sample bottle caps were acid cleaned and installed before every sampling episode. A buried plastic trash barrel with lid, located down slope of the lysimeters, housed the sample bottles. Tubing running underground from the lysimeters to the sample bottles entered the barrel through cut holes.

Prior to field installation, all materials were cleaned of possible contaminants to ensure they were suitable for sampling for Hg and other trace metals. Pyrex glass and the fiberglass wicks were baked for 2½ hours at 500°C in a muffle oven and rinsed with low-Hg deionized water. Pyrex glass parts were washed with Liquinox detergent prior to baking. Knutson *et al.* (1993) found that combustion of the wicks at 400°C removes over 98% of impurities within 3 hours. Teflon tubing was rinsed 3 times with low-Hg deionized water.

Soil water collectors were installed in the field by digging soil pits approximately 90 cm long, 60 cm wide, and 75 cm deep. Lateral tunnels 20 cm deep were excavated in the uphill direction so that the collectors could be placed under undisturbed soil. The soil surface that was to come into contact with the lysimeter was prepared by inserting a sharpened sheet of stainless steel (20 gage) horizontally into the soil. Soil under the sheet was removed and the collectors were placed vertically within the soil directly under the steel sheet. A small amount of soil was poured onto the top of the sampler so that the settling of soil would not cause the lysimeter to lose contact with the soil horizon. The sheet was then carefully removed so as not to disturb any soil above it. Samplers were firmly wedged up against the prepared soil surface and tunnels were back-filled with moistened soil. The lysimeters were transported to the field in three layers of Ziploc bags and inserted using particle-free gloves. Two shallow collectors (just below the Oa horizon, 4–7 cm below ground surface) and two deep collectors (below the Bhs or within the B horizon, 22–28 cm below ground surface) were installed at each of two sampling locations along Nettle Brook (Middle and Upper sites shown on Figure 1). At the Stream 10 site, it was only possible to install one lysimeter at each depth because of rock obstructions and seasonal time constraints. A total of 10 lysimeters were installed between 26 September and 18 December 1996.

Soil solution and stream samples were collected during spring snowmelt and major rain events between 20 April and 3 November 1997. Bottles for collecting soil solution were set out just prior to each storm event and were collected when the bottle was full or after precipitation ended. Grab samples of stream water were collected during storms near the three soil water sites and at the Nettle Brook weir (Figure 1), with an attempt to collect successive samples during the storm as stream flow increased, crested, and descended. Typically it was only possible to sample once before and once after stream flow peaked. Appendix A presents flow data for the Nettle Brook weir and Stream 10.

Soil samples were also collected in December 1997 at each soil water sampling site within a 10 m vicinity of the lysimeters. Soil samples were collected at two depths (4–7 cm and 22–28 cm, or the same horizons where the lysimeters were placed) using a soil corer. Soil that did not come in contact with the corer was collected into acid-cleaned polypropylene vials.

Clean technique was used in handling all samples: all equipment and supplies used in sampling were rigorously acid-cleaned in a 4- or 11-day cycle (Burke *et al.*, 1995); sample bottles were Teflon-taped and triple-bagged; and particle-free gloves were worn when handling the samples.

2.3 SAMPLE PROCESSING

Upon collection, samples were brought to PMRC in Underhill Center, VT. Subsamples were poured off inside a portable counter-top HEPA-filtered clean chamber for analysis of pH, conductivity, DOC, color, and major ions. Samples for Hg and trace metals analyses were shipped by overnight courier to the University of Michigan Air Quality Laboratory (UMAQL) in Ann Arbor, MI where they were oxidized with BrCl to a 1% solution and refrigerated until analysis. Subsamples of those samples with sufficient volume were filtered before oxidation through 0.22-µm nitrocellulose filters (Millipore MF) to separate operationally-defined dissolved and particulate fractions. This size filter was chosen to maximize discrimination between dissolved Hg and Hg associated with particles.

Subsamples retained at PMRC were analyzed for pH (Orion EA920) and conductivity (VWR Scientific EC 2052), and then filtered using a 0.7-µm glass fiber syringe filter (Whatman 13-mm ZC GF/F). This size filter was chosen because it is the smallest glass fiber syringe filter available. Filtered water samples were refrigerated until analysis for DOC, color, and major ions.

Soil samples were shipped to UMAQL where they were dried, ground with acid-cleaned glass mortars and pestles, and microwave digested with 10% HNO_3 as described in Rea and Keeler (1998).

2.4 LABORATORY ANALYSIS

All Hg analysis was performed at the UMAQL in a Class 100 clean room using cold vapor atomic fluorescence spectrometry (CVAFS). For total Hg determination in soil water and stream water, the oxidized Hg was reduced by NH_2OH and $SnCl_2$ to elemental Hg, bubbled out of solution in a Hg-free nitrogen gas stream, and captured onto a gold-coated bead trap. The Hg was then thermally desorbed from the trap in a Hg-free helium gas stream and quantified by CVAFS using dual amalgamation (Fitzgerald and Gill, 1979). Calibration curves covering the appropriate concentration levels were run each day of analysis with control standards checked after every sixth sample. The analyzer was recalibrated if the control standard was not within 10% of the expected value. No Hg speciation analysis was performed; all Hg data are total Hg measurements.

Trace metal analysis at UMAQL was conducted on a Perkin-Elmer Elan 5000A inductively coupled plasma-mass spectrometer (ICP-MS) equipped with a thin film electron multiplier. The elements that were analyzed on this machine include Li, Be, Mg, Al, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, As, Rb, Sr, Cd, Ba, La, Ce, Nd, Sm, Tl, and Pb. The full set of analytical results is presented in Appendix B.

DOC was determined by ultraviolet persulfate oxidation with infrared detection at the USGS laboratory in Albany, New York using a Dohrman C analyzer. Color was analyzed on a UV-visible recording spectrophotometer (Shimadzu UV160U) at the University of Vermont School of Natural Resources. Absorbence at 420 nm was compared against a standard curve using platinum cobalt (Pt Co) solutions (Fischer SP120-500) (Black and Christman, 1963).

Major elements and ions (Ca, K, Mg, Na, S, Si, P, NH_4^+, Cl^-, NO_3^-, PO_4^{3-}, and SO_4^{2-}) were analyzed following standard methods (as specified in *Standard Methods for the Examination of Water and Waste Water*) at the University of Vermont Agricultural and Environmental Testing Laboratory. A Perkin-Elmer Optima DV inductively coupled plasma atomic emission spectrophotometer (ICP-AES) was used to measure concentrations of elements. Nitrate and ammonium were determined by colorimetric analysis on a Lachat QuikChem AE flow injection analyzer. Chloride, phosphate, and sulfate were measured by chemically suppressed ion chromatography using a Dionex 2000 series instrument. In addition to the water samples, soil samples collected from the study sites were analyzed for C, H, and N. These samples were analyzed using an Exeter Analytical CE440 CHN elemental analyzer.

2.5 STATISTICAL ANALYSIS

Data were analyzed using the Statistical Analysis System software (SAS Institute, Cary, NC). To compare mean concentrations of Hg, DOC, color, and pH, stream data were grouped by filter category (unfiltered = total concentrations, filtered = dissolved concentrations) and by site. Stream data for the four variables had a normal distribution and equal variances. Mean stream concentrations by filter category and site were compared using a Dunn multiple comparison t-test with a Bonferonni adjustment to control the α level (0.05) across sites. The four stream sampling sites were considered independent of each other. One value (total Hg of 9.2 ng L^{-1} at the Nettle Brook weir) was determined to be an outlier using Grubb's test and was excluded from the statistical analysis.

Mean concentrations of Hg, DOC, color, and pH in soil water samples were compared by depth and site. Soil water concentrations did not have a normal distribution and variances were unequal. Two-way analysis of variance of ranked data indicated that there was a significant interaction between depth and site for all four variables. Therefore, separate analyses were completed to compare mean concentrations across depths and sites. Concentrations by depth (Oa vs. B) were compared using a non-parametric Wilcoxon analysis of variance test. Ranked soil water concentrations by site were compared using a Dunn multiple comparison t-test with a Bonferonni adjustment to control the α level (0.05) across sites. Samples collected at different depths at the same site were considered independent of each other.

Pearson correlation coefficients were calculated for all variables in stream water and soil water samples. For the correlation analysis, stream water samples were grouped by filter category and site; soil water samples were grouped by depth and site.

3. RESULTS

3.1 SOILS

Two soil samples were collected at two depths at each of the three study sites. Results from two samples (Oa depth at the Upper Nettle and Stream 10 sites) are not available because of possible contamination in one of the samples and laboratory error in the other. Because of the small number of samples collected, the data give only a general idea of the level of Hg in soils at the sites. The average Hg concentrations at the Oa horizon (4–7 cm below ground surface) were 151.0, 309.4, and 169.0 ng g^{-1} (dry weight) at mid Nettle, upper Nettle, and Stream 10, respectively. Oa soils at these sites contained 11–18% carbon. The average Hg concentrations at the B horizon (22–28 cm below ground surface) were 68.9, 46.6, and 74.7 ng g^{-1} (dry weight) at the three sites, respectively. B horizon soils at these sites contained 1.4–3.7% carbon.

At all sites, Hg concentrations in soil were higher in the Oa horizon than in the B horizon. Other trace metals that followed this trend include As, Ba, Cd, and Pb. Several other trace metals followed the opposite trend, with higher concentrations in the B horizon, including Al, Ce, Cr, La, Mg, Mn, Ni, and Zn. Figure 2 presents the concentrations of a representative subset of the trace elements. Tables B-1 and B-2 in Appendix B include all soil data.

3.2 SOIL WATER

Soil water was collected during one spring snowmelt event and eight summer and fall rainstorms between 20 April and 3 November 1997 at the Nettle Brook sites, and during six summer and fall rainstorms at the Stream 10 site. Table 1 presents concentrations of Hg, DOC, color, and pH in these samples. Although some soil water samples were filtered, only the total Hg and trace metals concentrations are presented here because there are so few filtered samples and we assumed that the fiberglass wick acted as a filter. Volume-weighted means are not presented because they were very similar to the simple means.

Concentrations of Hg were significantly higher in Oa horizon soil water than in B horizon water at all three sites (Table 2). DOC and color were also higher in the Oa horizon soil water, but significance varied by site (Tables 3 and 4). Mercury, DOC, and color were significantly lower at the upper Nettle site than the other sites at both depths. Two-way analysis of variance of ranked data indicated that there was a significant interaction between depth and site for all four variables, mainly because soil water concentrations are so much lower at the Upper Nettle site. The upper Nettle site is located on a wet hillslope.

Soil water pH at all sites was lower in the Oa horizon, but the difference was only statistically significant at the mid Nettle site (Table 5). Soil water pH at the Stream 10 site was significantly lower than the Nettle sites at both depths. Stream 10 is the site at highest elevation.

Mercury in Oa horizon soil water was positively correlated with DOC and color at all three sites ($r^2 = .81–.98$, $p = .03–.0002$ at individual sites) (Figure 3, sites grouped together). In B horizon water, the positive correlation between Hg and DOC or color was not as strong but sample sizes were smaller. Hg in soil water was most consistently correlated with DOC and color but also tended to be positively correlated with As, Cu, Pb, Ti, and rare earth metals (Ce, La, Sm), and negatively correlated with K, Na, Rb, and NO_3. Correlations between a subset of these chemicals are presented in Tables 6 and 7.

Most trace metals followed the pattern of higher concentrations in Oa horizon soil water than in B horizon water. However, no trace metals were analyzed in B horizon water at the mid Nettle site because of insufficient sample volumes collected at this depth. At the Stream 10 site, several trace metals and ions followed the opposite trend and were present in higher concentrations in B horizon soil waters, including Ca, Cr, Mg, Mn, Na, Si, SO_4, and Zn. Figure 4 presents the concentrations of a representative subset of these elements. Table B-3 in Appendix B includes all soil water data.

3.3 STREAM WATER

Stream samples were collected near the three soil water sampling sites and at the Nettle Brook weir during rain events when soil water was collected. Table 8 presents concentrations of total and dissolved Hg, DOC, color, and pH in the stream water. There were no statistically significant differences in the total Hg, dissolved Hg, and DOC concentrations between sites. Color at the upper Nettle location was significantly higher than at Stream 10 ($F = 4.25$, $p = .0096$). The upper Nettle site is directly downstream from a boggy area. Stream pH was significantly higher at the lowest elevation site (Nettle weir) and significantly lower at the highest elevation site (Stream 10) ($F = 335.47$, $p = .0001$).

Total and dissolved Hg were positively correlated with DOC and color at all sites ($r^2 = .51–.96$, $p = .09–.001$ for each site) (Figure 5, sites grouped together). Total and dissolved Hg were also positively correlated with Al, As, Cu, Cr, Ni, Pb, Ti, V, rare earth metals (Ce, La, Nd, Sm), and stream temperature. Mercury tended to be negatively correlated with Cl, Na, and SO_4. Correlations between a subset of these chemicals are presented in Tables 9 and 10.

Concentrations of most analytes were higher in soil water than in stream water. Exceptions to this trend occurred at Stream 10 (for Cu, La, Mn, Ce) and at the upper Nettle site (for As, Ba, Mn), where stream concentrations of these elements exceeded soil water concentrations by 6–58%. Mercury and V in stream water were roughly equal to that of soil water at the upper Nettle site. The upper Nettle site is on a wet hillslope with many seeps.

At the Nettle weir, where flow rate was continually measured, total Hg (particulate + dissolved) and most other trace metal concentrations increased as flow increased. Dissolved Hg concentrations, on the other hand, only slightly increased as flow increased. This was also true for Cu, but dissolved Al, Nd, and Pb increased as flow increased. Concentrations of dissolved Ca, Mg, Si, and SO_4 became diluted as flow increased, which is a typical pattern for groundwater-derived chemicals. At lower flow conditions, Hg had a higher dissolved proportion than most trace metals but as flow increased, more and more Hg was associated with particles (Figure 6). Although other trace metals such as Al, Cu, Ce, and Pb also followed this pattern, it is notable that Hg and Ti (a crustal element) show the strongest decrease with flow. Table B-4 in Appendix B includes all stream chemical data.

4. DISCUSSION

The chemical composition of soils, soil water, and stream water reflects a combination of human influence and biogeochemical processes. Here we use the behavior of Hg, DOC, and trace metals in these three media to propose a model for the transport of Hg from soils to streams at our study sites.

4.1 SOILS

In soils, Hg had higher concentrations in the Oa horizon than in the B horizon, as did As, Ba, Cd, and Pb. These elements have atmospheric sources, and their prevalence in the Oa horizon probably reflects accumulation resulting from atmospheric deposition. Mercury and Cd are byproducts of coal and other fuel combustion, Cd and As come from the non-ferrous metal industry; and Pb was formerly used as an additive in gasoline (Nriagu and Pacyna, 1988). Barium has recently been proposed to be a good indicator of unleaded gasoline and diesel oil emissions (Monaci and Bargagli, 1997). The elements Al, Ce, Cr, La, Mg, Mn, Ni, and Zn, had higher concentrations in the B horizon. These elements have a crustal origin, and are likely present as products of bedrock weathering, although Cr, Mn, Ni, and Zn can also have atmospheric sources (Driscoll *et al.*, 1988; Nriagu and Pacyna, 1988).

Soils are a net sink for atmospherically deposited Hg. Using the Hg input–output balance at Nettle Brook presented by Scherbatskoy *et al.* (1998) and a re-volatilization rate of 90 mg ha^{-1} yr^{-1} (in Sweden; Bishop *et al.*, 1998), we conclude that Hg is accumulating in catchment soils. Although the current levels of Hg in soils at Nettle Brook and Stream 10 are not known to pose a

direct environmental threat to the forest ecosystem, they could reach the 0.4–0.5 μg g^{-1} Hg guideline proposed in Switzerland for soil microbiological health (Johansson *et al.*, 1991) after another century of atmospheric deposition (Shanley *et al.*, in press), provided the current levels primarily reflect anthropogenic inputs. It is possible that acid deposition may favor accumulation of Hg and other trace metals that complex with organic matter, as McDowell and Likens (1988) have suggested that anthropogenic acidification of precipitation may have slowed the turnover of DOC in mineral soils by decreasing the mobility of organic anions in soil. In addition, acidic conditions favor the adsorption of Hg to organic compounds. Maximum adsorption to soils and soil organic matter has been observed to occur between pH 3 and 5 (Thanabalasingam and Pickering, 1985; Yin *et al.*, 1996)

4.2 SOIL WATER

The observed pattern of higher Hg (or other trace metals) and DOC in Oa horizon soil water than B horizon soil water has been noted in part by others (McDowell and Wood, 1984; Bergkvist, 1987; Driscoll *et al.*, 1988; Lazerte *et al.*, 1989; David *et al.*, 1992; Bishop *et al.*, 1995). These analytes also tended to have higher soil water concentrations than stream water concentrations, indicating that additional adsorption of these ions and metals occurs as water percolates downward and discharges into the streams as groundwater. Removal of DOC and trace metals in the upper part of the B horizon is a part of natural soil formation. Organic compounds and, by association, trace metals are mobilized in the organic layers of the soil by biologic activity, and these compounds are removed from solution when organic anions adsorb to precipitated Fe and Al hydroxides in the B horizon (Bergkvist, 1987; Cantrell, 1989). The export of Hg to streams is therefore dependent on processes that affect the export of dissolved organic compounds. At Hubbard Brook in New Hampshire, less than 10% of the DOC leaving the forest floor in soil solution is ultimately exported to streams (McDowell and Likens, 1988). Correspondingly, the relatively high Hg concentrations we found in Oa horizon soil water represents Hg that will largely be retained in the catchment, attached to soil or re-volatilized to the atmosphere.

The factors that affect the mobilization of Hg and DOC in soil solution are complex. We found no correlation between pH and Hg in soil water. DOC and pH were negatively correlated in B horizon soil water only (Table 7). Johansson *et al.* (1991) also found no correlation between acidification of soil and water and Hg concentrations, and McDowell and Likens (1988) cited several studies which found no correlation between pH and DOC in soil solutions. Some trace metals that were positively correlated with Hg did have a negative relationship with pH in soil water, including Al, As, Ba, Pb, Cu Ti, and rare earth elements (Tables 6 and 7). At Stream 10, where pH in soil water and stream water was significantly lower than at other sites, soil water and stream concentrations of Al, Cu, Ce, Pb were elevated compared to the Nettle sites, suggesting increased mobilization of these chemicals by the decreased pH. Trace elements may also be retained less at Stream 10 because of shallow bedrock at the site. Mercury did not appear to be affected by the low pH or other factors that contributed to increased export of other trace metals at Stream 10, although the mechanisms for this are unclear.

There was a slight inverse relationship between both Hg and DOC and the volume of water collected in soil water samples. This suggests that the contact time between water and soils may be important, and that simply increasing water flow through the soils will not necessarily mobilize more Hg and DOC. It is also possible that an initial pulse of Hg is mobilized in soil water during a rain event and the Hg becomes diluted as additional water percolates through the soil. We were able to collect two samples during the same rain event only once (from the Oa horizon at Stream 10). Mercury concentrations of 15.3 and 7.7 ng L^{-1} were measured in the first

and second samples, respectively. Corresponding DOC concentrations for these samples did not reflect a decline, however; both measured at 13.8 mg L^{-1}.

There are two concerns with regard to the soil water results. Increased N mineralization is a concern in any study during which soil is disturbed (Johnson *et al.*, 1995; Lawrence and David, 1996), and our study involved installing lysimeters. Nitrate concentrations in the soil water samples (0.001–12.285 mg L^{-1}) indicated a lingering disturbance effect on the soil. If the NO_3 levels signify an increase in decomposition and additional release of organic carbon, this might have caused elevated Hg concentrations in soil water. At most sites and depths, there was no correlation between Hg and NO_3, however. In fact, Hg in Oa horizon soil water at Mid Nettle and at Stream 10 was negatively correlated with NO_3 ($r^2 = -.74$, $p = .01$ and $r^2 = -.77$, $p = .07$, respectively). We also observed no correlation between NO_3 and DOC. Other potential effects of nitrification include increased soil acidity and increased loss of calcium and other nutrient cations. In our soil water samples, NO_3 was not correlated with soil water pH but was positively correlated with elements such as Mg, Zn, Sr, Ca, and K. A causal link between NO_3 and these cations cannot be established, however.

The other concern is that soil water pH levels at the Nettle Brook sites (4.68-6.97) were higher than expected. Soil water pH should not be much higher than that of incoming rain (pH ~4.40 in annual average precipitation) or the surrounding soil (4.10–4.40). At the upper Nettle site, the soil water might have a groundwater influence, which would partially explain a higher pH. The mid Nettle site is not a wet site and these soils do not have high pH. A possible explanation for the elevated pH levels we observed in soil water samples is that the fiberglass wick lysimeters somehow changed the pH of the percolating solution, but we have no direct evidence that this occurred. Higher pH might cause organic acids and Hg-organic complexes to become more soluble, thus artificially increasing the Hg concentrations in soil water samples. However, as mentioned earlier, we did not find a correlation between pH and Hg in soil water.

4.3 STREAM WATER

At the Nettle Brook weir, flow-related increases in total stream water concentrations of Hg and also Li, Al, Ti, Mn, Co, Cu, Zn, Cd, La, Ce, Nd, Sm, and Pb were observed during our study. The majority of Hg transport occurs during the highest flow events, particularly during years of significant and rapid snowmelt (Scherbatskoy *et al.*, 1998). Release of Hg in rivers and stream water during increased flow events has been shown to be related to sediment transport (Balogh *et al.*, 1997; Scherbatskoy *et al.*, 1998).

Dissolved stream water concentrations at the Nettle Brook weir were not as sensitive to stream flow rate as the total (dissolved + particulate) concentrations were. As observed in previous years of study (Scherbatskoy *et al.*, 1998), dissolved Hg concentrations only slightly increased with increased flow. In this study we can compare Hg concentrations with DOC and trace metal concentrations for the first time. The elements that did exhibit an increase in dissolved concentrations with increased flow rate were Li, Al, Zn, Cd, Ce, Pb, and K. DOC and color also increased with flow, but the relationship was weaker. Copper and Ti had minimal increases, similar to the behavior of Hg. The pattern of Hg as a function of stream flow points towards stream flow rates and the amount of suspended sediment as being critical to the behavior of Hg.

Differing laboratory protocol for filtering trace metal samples (0.22 μm) and DOC samples (0.7 μm) must be considered when comparing results of dissolved and total concentrations. Complexes that passed through the 0.7 μm filter but were excluded by the 0.22 μm filter were counted as dissolved in the DOC measurement but considered particulate phase in the Hg and trace metals measurements. Clay-humic-metal complexes range in size from 0.007 μm to 2 μm (Thurman, 1985). This probably accounts for the better association we observed between DOC and total concentrations of Hg, rather than dissolved concentrations, in our stream samples (Figure 5). It might also help explain why we observed an increase in DOC with increased flow but a minimal increase in Hg. On the other hand, dissolved Al, Zn, Cd, and Pb did increase with flow.

4.4 MECHANISM OF HG TRANSPORT FROM SOILS TO STREAMS

An important question in this research is where is the Hg in streams coming from, and what role do soils play in supplying this Hg? The majority of Hg exported from Nettle Brook is associated with the particulate phase (62 and 74% during two years of study; Scherbatskoy *et al.*, 1998). Sediment carrying adsorbed Hg and other trace metals may be supplied by re-mobilization of in-stream sediments, overland flow, and soil erosion from stream banks. Eroded or fallen leaf matter is also a contributor to particle-associated Hg in streams.

Data on concentrations of DOC and trace metals can be used to develop a possible scenario for the origin of dissolved Hg. If upper Nettle B horizon soil water is representative of discharging groundwater (due to its origin in a wet hillslope with seeps and its 80:1 La:Ce ratio, which is different than the 2:1 ratio found in all other soil water samples in our study), then DOC and Hg levels in Nettle Brook stream water are higher than groundwater even during base flow. Under low flow conditions, DOC is supplied to streams not only by groundwater but also by litterfall (25% and 44% of DOC, respectively; Thurman, 1985). Mercury associated with humic substances is therefore supplied to streams by both decomposed allochthonous organic material and discharging groundwater.

During periods of increased flow, dissolved Hg must have additional sources otherwise we would observe a decrease in concentration from dilution. Sources of dissolved Hg during high flow events must therefore include inputs of Hg from soil water, Hg in rainfall or throughfall directly deposited into the stream, and Hg mobilized in newly inundated areas of the stream channel and banks (Lindberg and Turner, 1988; McDowell and Likens, 1988). Macropore flow and groundwater ridging during high runoff periods, especially in riparian areas, aids in the delivery of water from soils to streams (McCarthy and Zachara, 1989; Buttle, 1994; Bishop *et al.*, 1995). Mercury and other solutes will be similarly transported. At our sites, dissolved Hg concentrations in streams during high flow were somewhat similar to Hg concentrations in B horizon soil water samples.

Based on the concentrations of Hg we observed in Oa soils and soil water, an event that causes a rise in the water table high enough to direct flow from the upper soil horizons to streams should cause more Hg and DOC to be exported to streams. However, we have never observed a dramatic increase in dissolved Hg at Nettle Brook. Instead, dissolved Hg represents a small but steady input to Nettle Brook. Why doesn't dissolved Hg seem to behave like DOC or dissolved Al, Zn, Cd, or Pb at Nettle Brook, which do increase with increased flow? It is possible that dissolved Hg coming from soil water or other sources during storms is quickly adsorbed by suspended organic particulate matter upon entry into the stream. Adsorption could occur immediately or in the sample bottle before analysis. The order of affinity to organic compounds ($Hg^{2+} > Cu^{2+} > Pb^{2+} > Zn^{2+} > Ni^{2+} > Co^{2+} = Cd^{2+} > Mn^{2+}$ (Cheam and Gamble, 1974; Förstner and Wittman, 1981; Takamatsu *et al.*, 1983)) might support these hypotheses, especially because dissolved Cu also did not increase much with flow. Mercury's relationship with reduced S functional groups on organic compounds (Xia *et al.*, 1999) might make adsorption onto suspended sediment more favorable for Hg-organic complexes than for complexes with other metals in uncontaminated waters.

Given that Hg is primarily exported in association with particulate matter in forest streams, land use practices that minimize soil erosion into streams (such as during logging) will also serve to limit transport of Hg to surface waters and ultimately to Lake Champlain. The fate of this Hg as it travels downstream towards Lake Champlain through agricultural and developed lands has not yet been explored. Much of the particulate phase Hg in upland watersheds may be re-deposited further downstream. Ultimately the Hg present in dissolved form may be enough to account for the Hg entering the food web in Lake Champlain, but no research has yet been done to look at the cycling of Hg in this lake and its watershed.

5. CONCLUSIONS

This study shows that dissolved Hg is associated with dissolved organic compounds, and that Hg in streams during storm flow may be in part influenced by Hg in soil water. Most dissolved Hg in Oa horizon soil water is probably removed from solution before reaching streams, however, by adsorption onto soil solids. Although Hg was positively correlated with elements such as Al, As, Cr, Cu, Ce, and Pb, it did not show increased export at higher elevation and lower pH as did other elements (Al, Cu, Ce, and Pb). During base stream flow, Hg was present in the dissolved form. Under high flow conditions, Hg was present primarily in association with suspended particulate matter. Dissolved Hg increased only slightly with increased stream flow, whereas other elements such as Al, Cd, and Pb did increase. Some of the dissolved Hg mobilized during a storm from the soil water may adsorb to suspended particles in the stream upon entry. Transport of Hg from soils to streams will be positively influenced by factors that increase the mobilization of organic acids, which might include global warming (through increased decomposition and increased precipitation).

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Table 2. Analysis of variance tables for mercury concentrations in soil water.

Two-way analysis of variance table for differences in mean ranked soil water concentrations.

Source (ranked Hg)	d.f.	F	p
site	2	37.22	0.0001
depth	1	57.74	0.0001
site x depth	2	3.76	0.0319

Wilcoxon one-way analysis of variance table for differences in mean soil water concentrations by depth (Oa vs. B) at each site.

Hg by Site	n (Oa)	n (B)	Z	p
Mid Nettle	13	4	2.887	0.0039
Upper Nettle	10	9	2.901	0.0037
Stream 10	6	4	2.025	0.0428

Analysis of variance table for differences in mean ranked concentrations by site at each depth.

Ranked Hg	d.f.	F	p	Bonferroni (Dunn) t-test†
Oa soil water	2	37.44	0.0001	MN=ST>UN
B soil water	2	10.79	0.0012	ST>UN

† site names have been abbreviated as follows:
MN = Mid Nettle, UN=Upper Nettle, ST=Stream 10.

Table 1. Summary statistics for soil water concentrations from three sites in Underhill Center, VT collected 20 April to 3 November 1997. Oa and B refer to soil horizon.

Analyte	Parameter	Site					
		Mid Nettle		Upper Nettle		Stream 10	
		Oa	B	Oa	B	Oa	B
Hg	Ave.	20.1	3.0	3.5	1.1	16.6	6.6
(ng L^{-1})	Std. Dev.	7.2	1.1	1.8	1.7	7.4	3.3
	Range	9.3–34.9	1.9–4.5	1.1–7.7	0.1–5.6	7.7–29.4	2.5–10.2
	n	13	4	9	10	6	4
DOC	Ave.	22.7	2.4	2.5	0.6	18.8	11.3
(mg L^{-1})	Std. Dev.	7.7	0.4	1.0	0.3	5.1	5.5
	Range	9.5–36.1	2.1–2.7	1.0–4.5	0.3–1.2	13.8–26.1	5.6–16.7
	n	12	2	8	8	6	3
Color	Ave.	376	20	15	6.0	181	57
(mg L^{-1}	Std. Dev.	92	–	8.3	2.7	68	28
PtCo)	Range	263–502	–	9.2–33	2.6–9.2	119–265	37–88
	n	10	1	7	9	6	3
pH	Ave.	5.55	6.65	5.98	6.06	4.71	4.90
	Std. Dev.	0.65	0.51	0.43	0.52	0.48	0.34
	Range	4.68–6.58	6.06–6.97	5.47–6.70	5.45–6.86	4.22–5.49	4.57–5.24
	n	12	3	8	9	6	3

Table 4. Analysis of variance tables for color concentrations in soil water.

Two-way analysis of variance table for differences in mean ranked soil water concentrations.

Source (ranked color)	d.f.	F	p
site	2	70.82	0.0001
depth	1	51.47	0.0001
site x depth	2	4.21	0.0245

Wilcoxon one-way analysis of variance table for differences in mean soil water concentrations by depth (Oa vs. B) at each site.

Color by Site	n (Oa)	n (B)	Z	p
Mid Nettle	10	1	1.423	0.1547
Upper Nettle	7	9	3.155	0.0016
Stream 10	6	3	2.195	0.0282

Analysis of variance table for differences in mean ranked concentrations by site at each depth.

Ranked color	d.f.	F	p	Bonferroni (Dunn) t-test†
Oa soil water	2	79.35	0.0001	MN>ST>UN
B soil water	2	34.59	0.0001	MN=ST>UN

† site names have been abbreviated as follows:
MN = Mid Nettle, UN=Upper Nettle, ST=Stream 10.

Table 3. Analysis of variance tables for DOC concentrations in soil water.

Two-way analysis of variance table for differences in mean ranked soil water concentrations.

Source (ranked DOC)	d.f.	F	p
site	2	39.53	0.0001
depth	1	37.41	0.0001
site x depth	2	3.95	0.0290

Wilcoxon one-way analysis of variance table for differences in mean soil water concentrations by depth (Oa vs. B) at each site.

DOC by Site	n (Oa)	n (B)	Z	p
Mid Nettle	12	2	2.100	0.0358
Upper Nettle	8	8	3.213	0.0013
Stream 10	6	3	1.420	0.1556

Analysis of variance table for differences in mean ranked concentrations by site at each depth.

Ranked DOC	d.f.	F	p	Bonferroni (Dunn) t-test†
Oa soil water	2	29.82	0.0001	MN=ST>UN
B soil water	2	38.96	0.0001	ST>MN>UN

† site names have been abbreviated as follows:
MN = Mid Nettle, UN=Upper Nettle, ST=Stream 10.

Table 5. Analysis of variance tables for pH in soil water.

Two-way analysis of variance table for differences in mean ranked soil water concentrations.

Source (ranked pH)	d.f.	F	p
site	2	16.46	0.0001
depth	1	5.12	0.0299
site x depth	2	3.46	0.0425

Wilcoxon one-way analysis of variance table for differences in mean soil water concentrations by depth (Oa vs. B) at each site.

pH by Site	n (Oa)	n (B)	Z	p
Mid Nettle	12	3	2.093	0.0364
Upper Nettle	8	9	0.048	0.9616
Stream 10	6	3	0.645	0.5186

Analysis of variance table for differences in mean ranked concentrations by site at each depth.

Ranked pH	d.f.	F	p	Bonferroni (Dunn) t-test†
Oa soil water	2	8.34	0.0019	MN=UN>ST
B soil water	2	11.08	0.0019	MN=UN>ST

† site names have been abbreviated as follows:
MN = Mid Nettle, UN=Upper Nettle, ST=Stream 10.

Table 6. Pearson correlation coefficients for Oa horizon soil water samples. A subset of chemicals is shown. Vol. indicates sample volume collected. Only significant correlations are shown ($r^2 > | .5 |$, p-value indicated with asterisks defined at the bottom of the table).

Variable	Vol.	pH	DOC	Hg	Al	Ti	V	Mn	Cu	Zn	As	Pb	NO_3	Ca	Mg	Si
Vol.	n = 28															
pH	-.712***	n = 26														
DOC			n = 26													
Hg			.929***	n = 28												
Al		-.842***	.696*	.561*	n = 11											
Ti	-.799**		.901***	.924***		n = 11										
V	-.523*		.875***	.835***	.612*	.856***	n = 11									
Mn								n = 11								
Cu	-.587*		.863***	.848***	.675*	.767**	.910***		n = 11							
Zn										n = 11						
As			.824**	.718**	.661*	.744**	.939***	.574*	.826**		n = 11					
Pb		-.609*	.568*	.573*	.689*		.549*		.675*	-.607*		n = 11				
NO_3								.727**		.873***			n = 23			
Ca								.751**		.762**			.824***	n = 23		
Mg								.766**		.826**			.814***	.956***	n = 23	
Si	-.532**					.602*		.584*					.679***	.908***	.818***	n = 23

***	p≤ .001
**	p≤ .01
*	p≤ .1

Table 7. Pearson correlation coefficients for B horizon soil water samples. A subset of chemicals is shown. Vol. indicates sample volume collected. Only significant correlations are shown ($r^2 > | .5 |$, p-value indicated with asterisks defined at the bottom of the table).

Variable	Vol.	pH	DOC	Hg	Al	Ti	V	Mn	Cu	Zn	As	Pb	NO_3	Ca	Mg	Si
Vol.	N = 18															
pH	-.711**	n = 15														
DOC		-.647*	n = 13													
Hg			.790**	n = 18												
Al		-.924*	.983**	.993***	n = 5											
Ti				.930*	.884*	n = 5										
V				.881*	.818*	.983**	n = 5									
Mn						.863*	.927*	n = 5								
Cu		-.914*	.886*	.952**	.951**	.921*	.842*		n = 5							
Zn			.919*		.833*					n = 5						
As		-.944*	.910*	.958**	.965**	.898*	.811*		.996***		n = 5					
Pb		-.912*	.990***	.919*	.952**				.835*	.957**	.867*	n = 5				
NO_3							.806*	.961**					n = 11			
Ca		.735*						.869*					.884***	n = 11		
Mg		.686*											.872***	.950***	n = 11	
Si	-.548*	.711*						.861*					.823**	.972***	.936***	n = 11

*** p≤ .001
** p≤ .01
* p≤ .1

Table 8. Summary statistics for stream water concentrations from four sites in Underhill Center, VT collected 20 April to 3 November 1997.

Analyte	Parameter	Site Nettle Weir	Mid Nettle	Upper Nettle	Stream 10
Total Hg ($ng\ L^{-1}$)	Ave.	3.1	3.2	3.5	4.0
	Std. Dev.	1.4	1.2	1.3	1.0
	Range	1.0–5.9†	0.9–5.0	1.5–5.5	2.2–6.2
	n	12	13	13	13
Dissolved Hg ($ng\ L^{-1}$)	Ave.	2.2	2.2	2.4	3.0
	Std. Dev.	0.8	0.8	0.9	0.7
	Range	1.0–3.5	0.9–3.3	1.0–3.6	1.5–4.1
	n	13	13	13	12
DOC ($mg\ L^{-1}$)	Ave.	3.9	4.1	4.8	4.4
	Std. Dev.	1.5	1.6	1.9	1.0
	Range	1.5–6.2	1.7–6.6	1.6–7.1	2.1–5.8
	n	13	13	13	13
Color ($mg\ L^{-1}$ PtCo)	Ave.	44	42	54	29
	Std. Dev.	19	20	21	9
	Range	12–70	11–80	15–81	14–45
	n	13	13	13	13
pH	Ave.	6.13	5.54	5.57	4.43
	Std. Dev.	0.15	0.19	0.14	0.04
	Range	5.88–6.31	5.10–5.80	5.35–5.79	4.37–4.49
	n	13	13	13	13

† A value of 9.2 $ng\ L^{-1}$ was determined to be an outlier and was excluded from analysis. Table B-4 includes the full data set for this sample collected on 15 July 1997.

Table 10. Pearson correlation coefficients for unfiltered (total) stream water samples. A subset of chemicals is shown. Flow indicates flow rate of stream. Only significant correlations are shown ($r^2 > | .5 |$, p-value indicated with asterisks defined at the bottom of the table).

Variable	Flow	Temp.	pH	DOC	Hg	Mg	Al	Ti	V	Mn	Cu	Zn	As	Pb	Ca	Si
Flow	n = 39															
Temp.		n = 47														
pH			n = 52													
DOC		.602***		n = 52												
Hg				.829***	n = 51											
Mg			.859***			n = 51										
Al			-.867***			-.653***	n = 51									
Ti								n = 51								
V					.645***			.948***	n = 51							
Mn				.506***						n = 51						
Cu			-.875***			-.662***	.972***				n = 51					
Zn			-.915***			-.686***	.954***				.921***	n = 51				
As			-.654***	.577***	.664***	-.505***	.868***				.852***	.755***	n = 51			
Pb	.556***				.777***		.550***	.638***	.747***				.686***	n = 51		
Ca		.528***	.961***			.905***	-.846***				-.857***	-.886***	-.612***		n = 51	
Si			.711***			.739***	-.569***				-.513***	-.673***			.749***	n = 51

*** p≤ .001
** p≤ .01
* p≤ .1

Table 9. Pearson correlation coefficients for filtered (dissolved) stream water samples. A subset of chemicals is shown. Flow indicates flow rate of stream. Only significant correlations are shown ($r^2 > | .5 |$, p-value indicated with asterisks defined at the bottom of the table).

Variable	Flow	Temp.	pH	DOC	Hg	Mg	Al	Ti	V	Mn	Cu	Zn	As	Pb	Ca	Si
Flow	n = 39															
Temp.		n = 47														
pH			n = 52													
DOC		.602***		n = 52												
Hg		.569***		.748***	n = 51											
Mg			.837***			n = 51										
Al			-.908***			-.673***	n = 51									
Ti		.651***	.585***	.645***		.549***		n = 51								
V		.570***		.802***	.645***			.761***	n = 51							
Mn										n = 51						
Cu			-.893***			-.662***	.973***				n = 51					
Zn			-.917***			-.676***	.957***				.912***	n = 51				
As			-.740***	.542***	.680***	-.565***	.879***			.548***	.866***	.810***	n = 51			
Pb			-.870***		.560***	-.697***	.928***			.519***	.930***	.878***	.928***	n = 51		
Ca		.528***	.961***			.890***	-.881***	.639***			-.872***	-.884***	-.680***	-.830***	n = 51	
Si			.711***			.764***	-.588***	.531***			-.525***	-.667***		-.517***	.749***	n = 51

*** p≤ .001
** p≤ .01
* p≤ .1

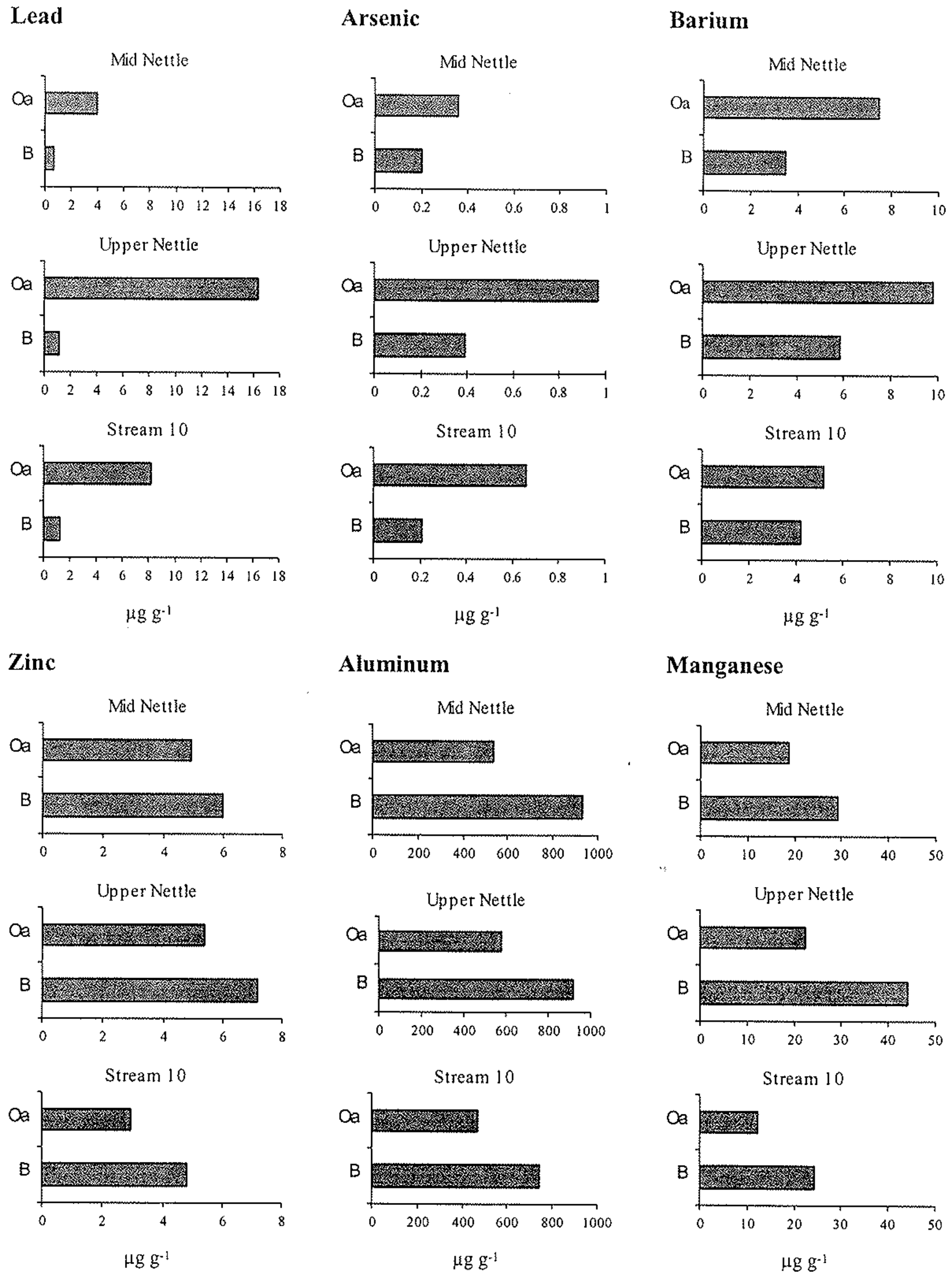


Figure 2. Mean concentrations (dry weight basis) of selected trace metals in Oa and B horizon soils (microwave digestion with 10% HNO_3) collected in December 1997 at Underhill Center, VT.

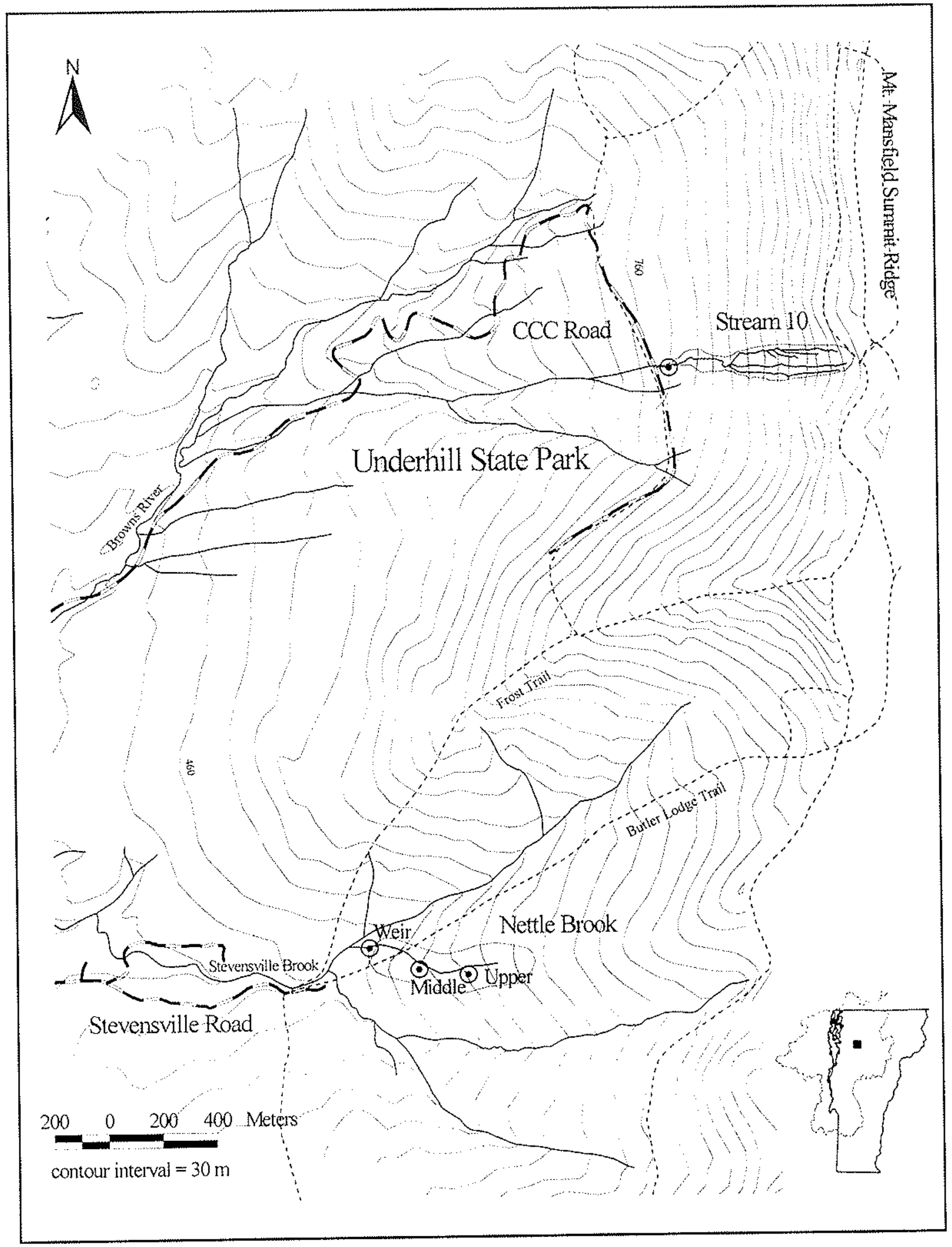


Figure 1. Site map. Circles indicate soil water and stream sampling locations. Inset shows the location of the study sites within the boundaries of Vermont and the Lake Champlain basin.

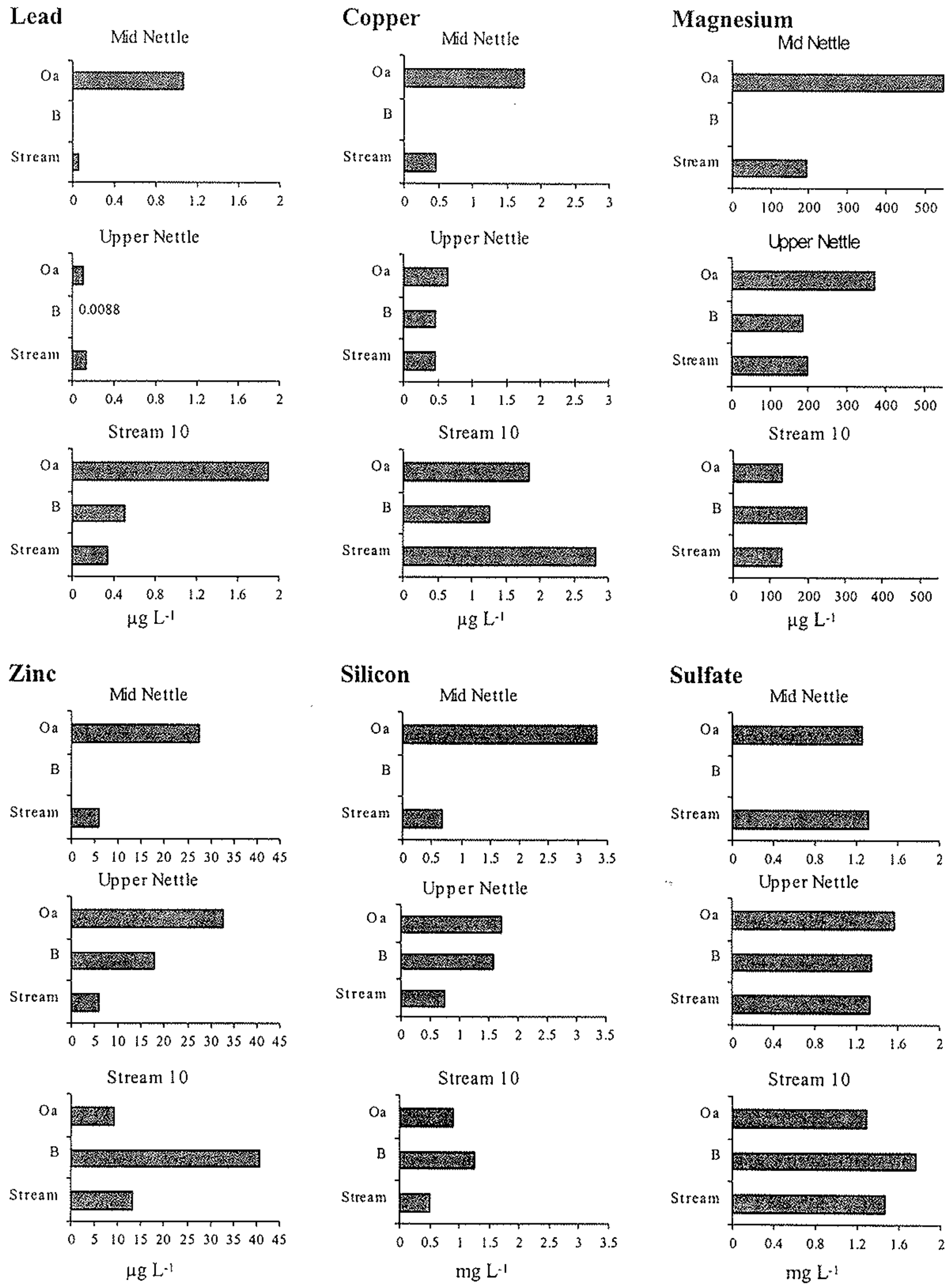


Figure 4. Mean concentrations of selected solutes in Oa and B horizon soil water and filtered stream water collected 20 April to 3 November 1997 at Underhill Center, VT. Most mean total concentrations were > 95% dissolved; only dissolved concentrations are shown here.

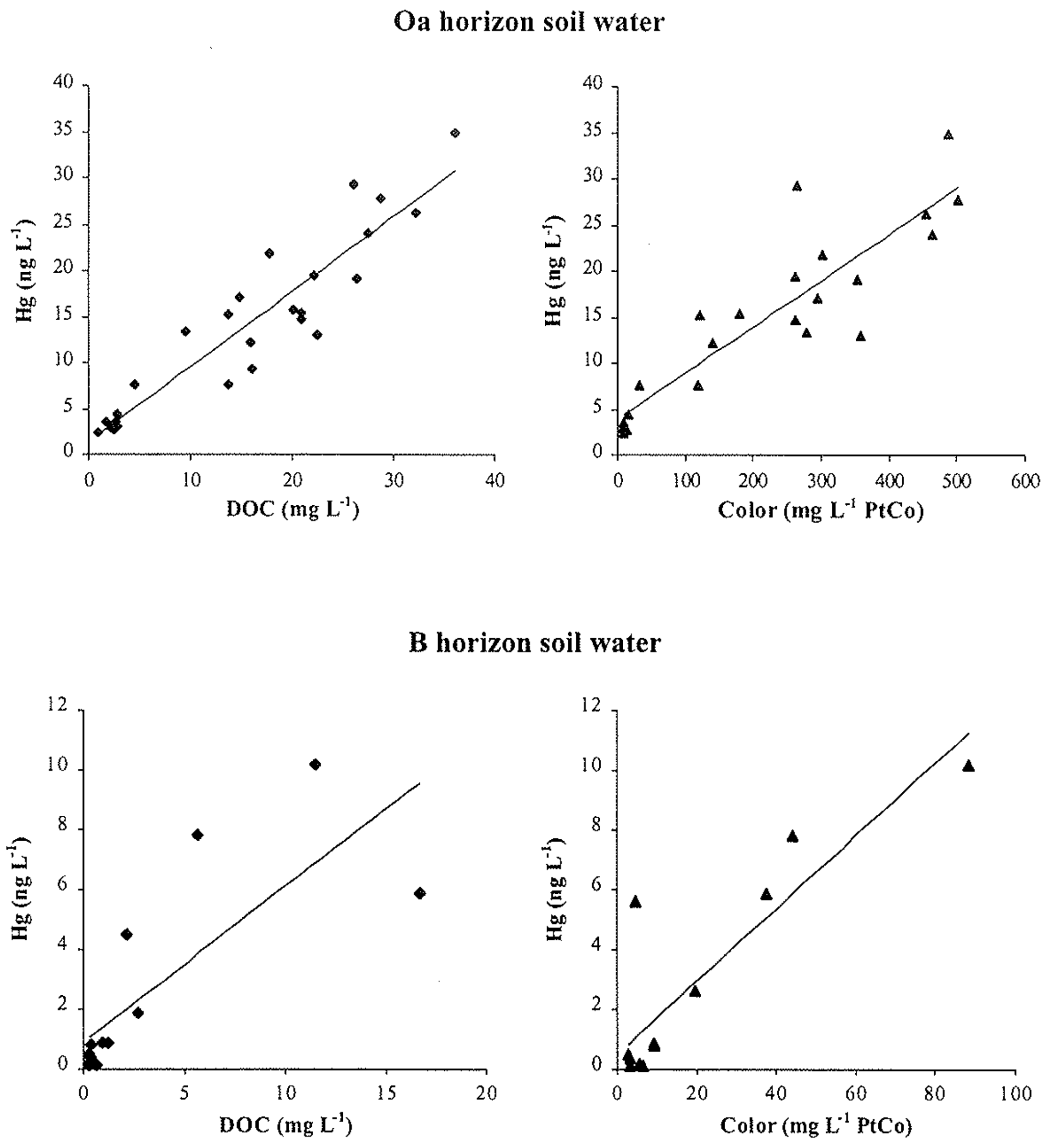


Figure 3. Scatter plots showing the relationship between Hg and dissolved organic carbon (DOC) and Hg and color in Oa and B horizon soil water grouped across all sites. Linear regression line is plotted. Correlation coefficients at each site are mentioned in the text.

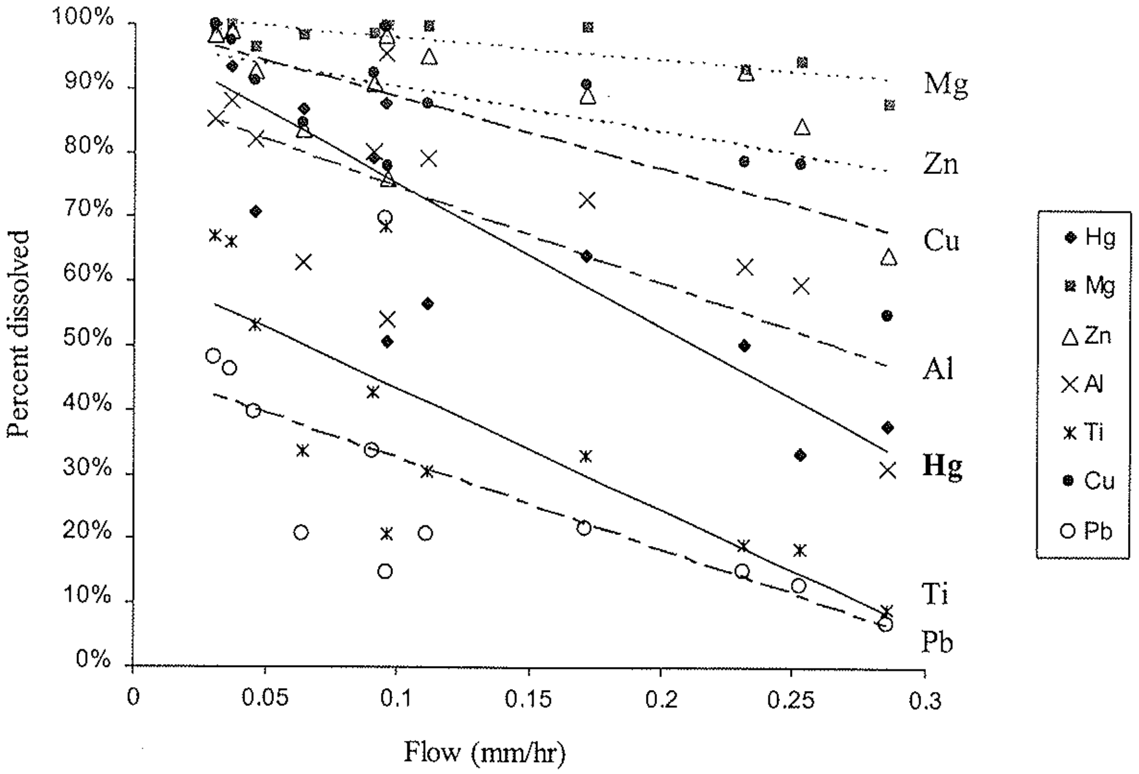
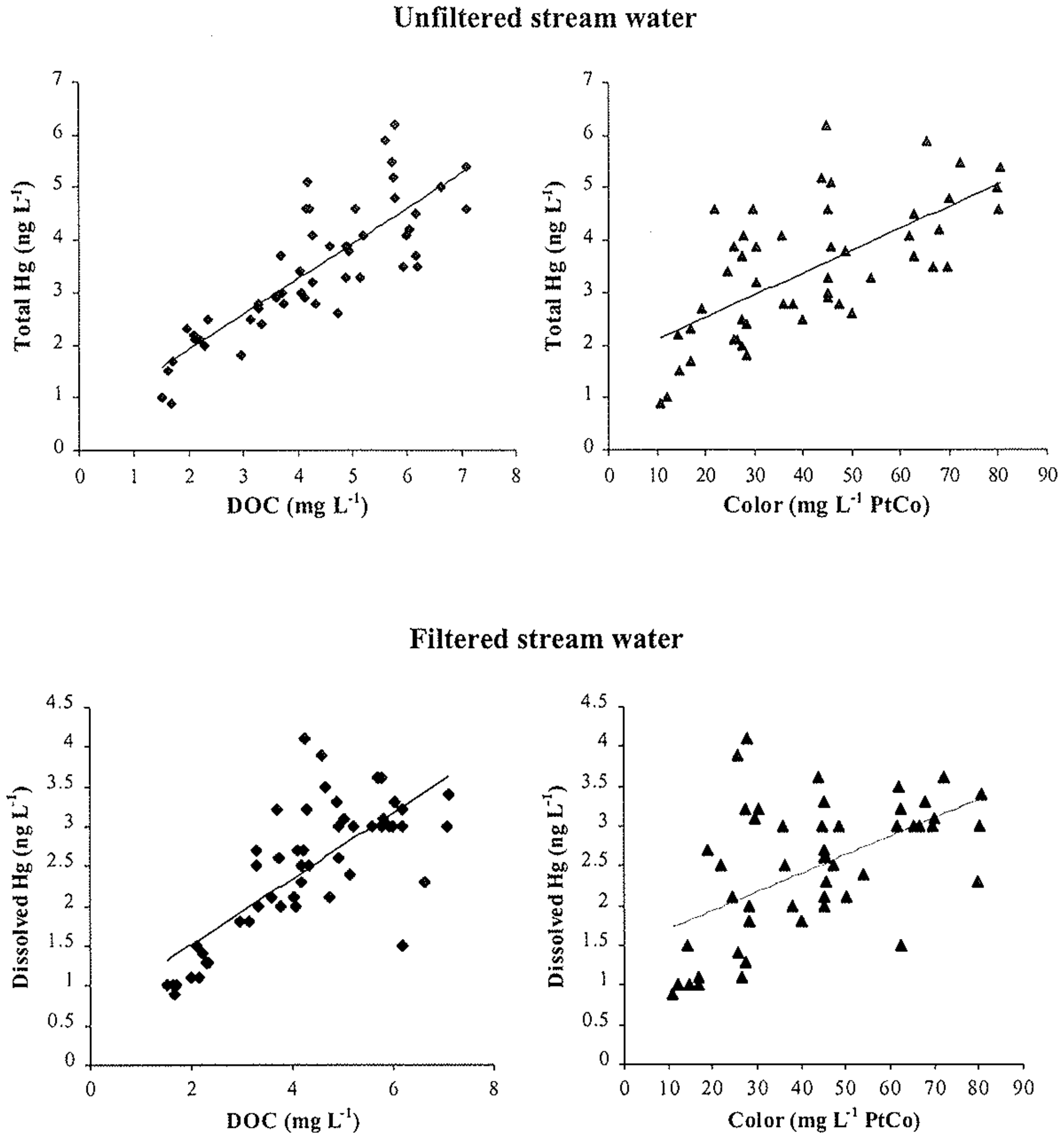


Figure 6. Flow rate vs. percent of total concentration in the dissolved phase at Nettle Brook weir for 13 stream samples collected from 20 April to 3 November 1997.


Unfiltered stream water

Filtered stream water

Figure 5. Scatter plots showing the relationship between Hg and dissolved organic carbon (DOC) and Hg and color in unfiltered (total Hg) and filtered (dissolved Hg) stream water grouped across all sites. Linear regression line is plotted. Correlation coefficients at each site are mentioned in the text.

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Appendix A

Stream Flow Graphs and Calculations

Table A-1. Worksheet for measuring flow in a culvert.

Stream 10

0.024 = constant for corrugated metal culvert
0.01 = slope (modified to fit measured numbers)
35 inches = culvert diameter

Water depth†	Theta	Area	Hydraulic radius	Manning's discharge	Measured discharge‡
in	radians	ft^2	ft	cfs	cfs
0.25	0.34	0.0068	0.0138	0.002	
0.50	0.48	0.0193	0.0276	0.011	
0.75	0.59	0.0354	0.0412	0.026	0.03
1.00	0.68	0.0543	0.0548	0.049	
1.25	0.76	0.0757	0.0683	0.079	0.071
1.50	0.83	0.0993	0.0817	0.116	
1.75	0.90	0.1249	0.0949	0.161	
2.00	0.97	0.1523	0.1081	0.215	
2.25	1.03	0.1813	0.1212	0.276	
2.50	1.08	0.2118	0.1342	0.345	0.246
2.75	1.14	0.2438	0.1471	0.422	
3.00	1.19	0.2772	0.1599	0.507	
3.25	1.24	0.3119	0.1726	0.600	
3.50	1.29	0.3477	0.1853	0.702	
3.75	1.33	0.3848	0.1978	0.811	
4.00	1.38	0.4229	0.2102	0.928	
4.25	1.42	0.4621	0.2225	1.053	
4.50	1.47	0.5023	0.2348	1.187	
4.75	1.51	0.5434	0.2469	1.328	
5.00	1.55	0.5855	0.2590	1.477	
5.25	1.59	0.6284	0.2709	1.633	
5.50	1.63	0.6723	0.2827	1.798	
5.75	1.67	0.7169	0.2945	1.970	
6.00	1.71	0.7623	0.3061	2.150	

† Average depth of water in culvert on west side of CCC Road.
‡ Determined in the field by measuring the time it took to fill a bucket of known volume.

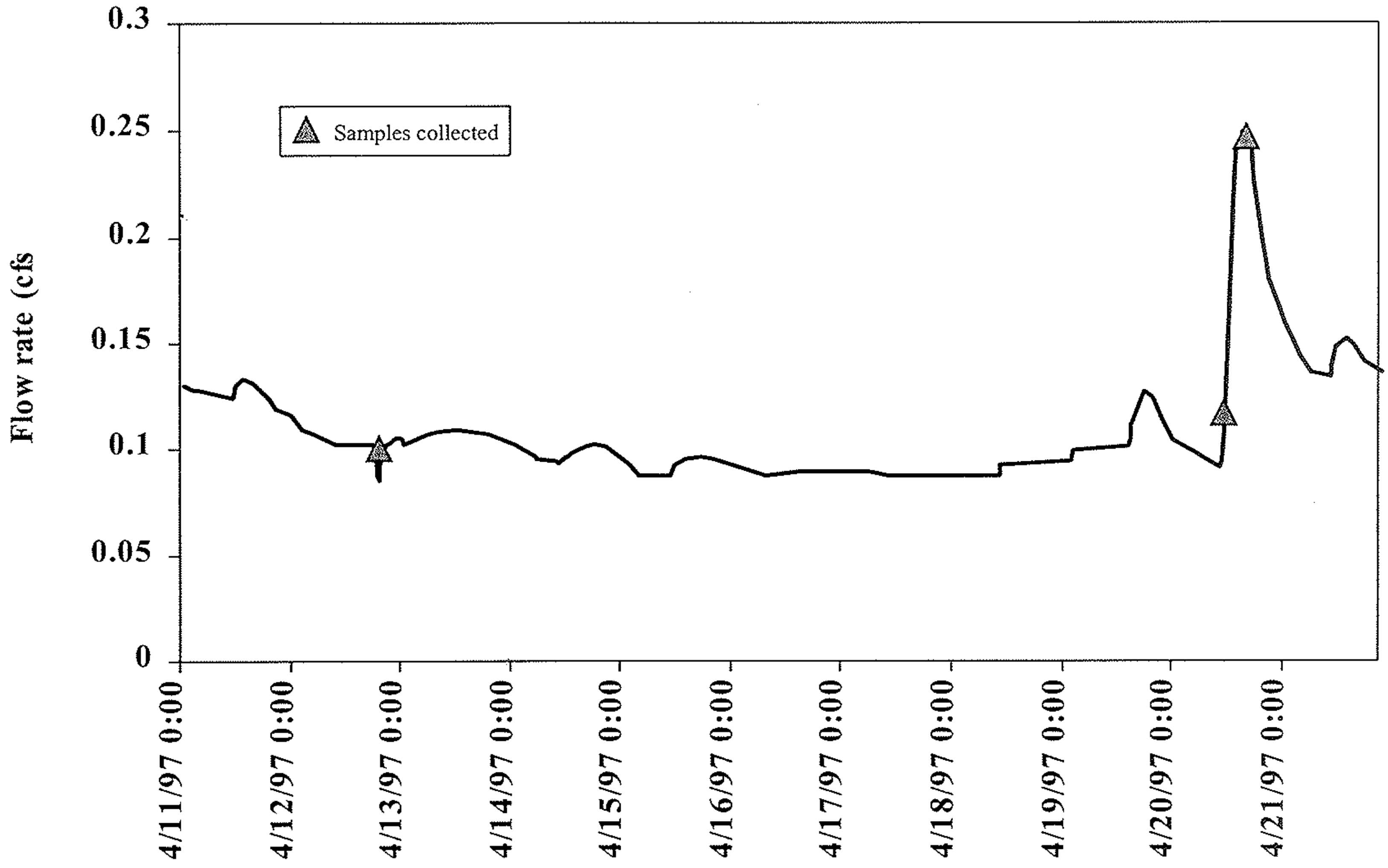

Figure A-2. Flow at Nettle Brook weir 11–21 Apr. 1997.

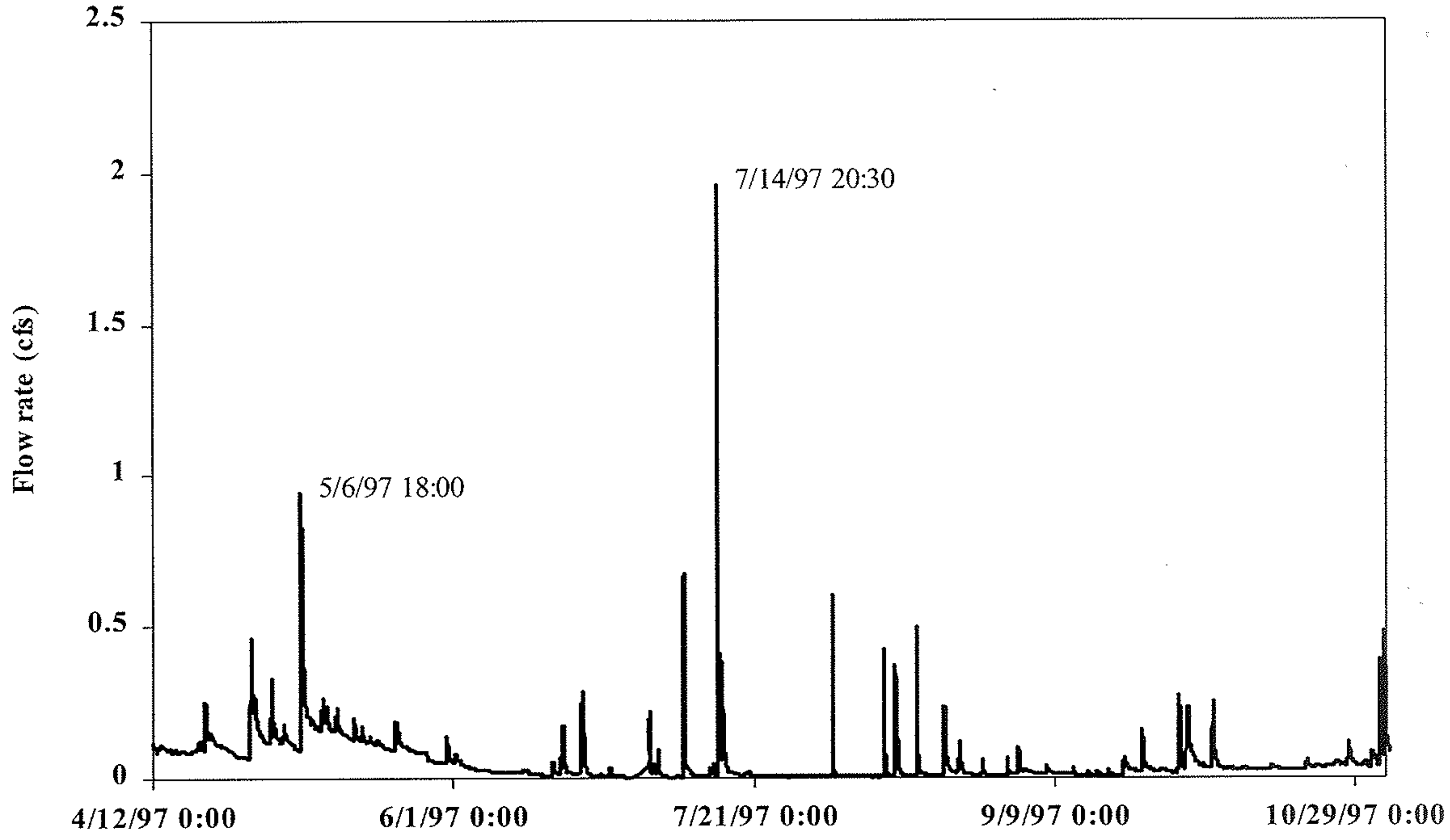

Figure A-1. Flow at Nettle Brook weir 12 Apr. to 3 Nov. 1997.

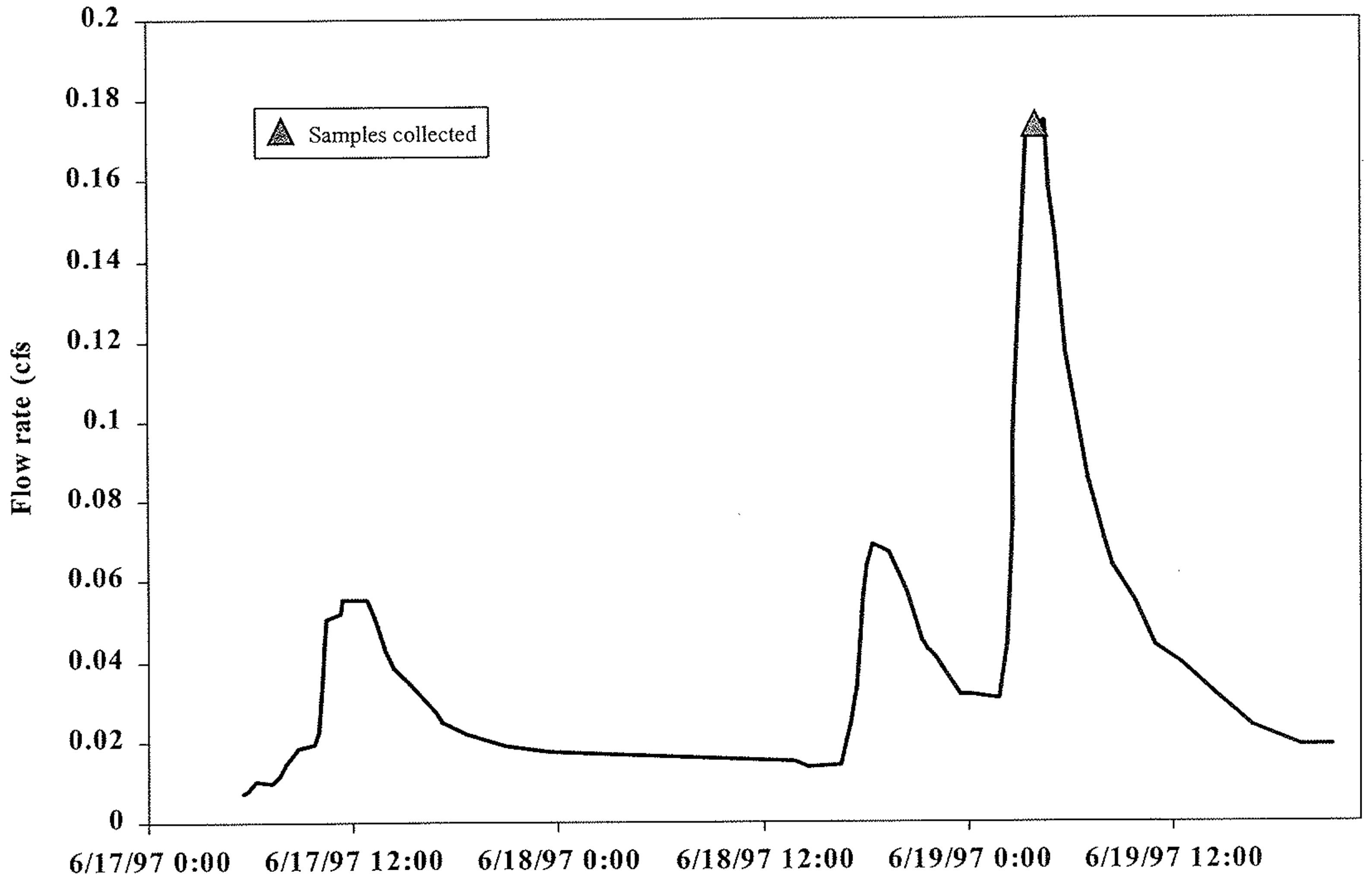

Figure A-3. Flow at Nettle Brook weir 17 – 19 June 1997.

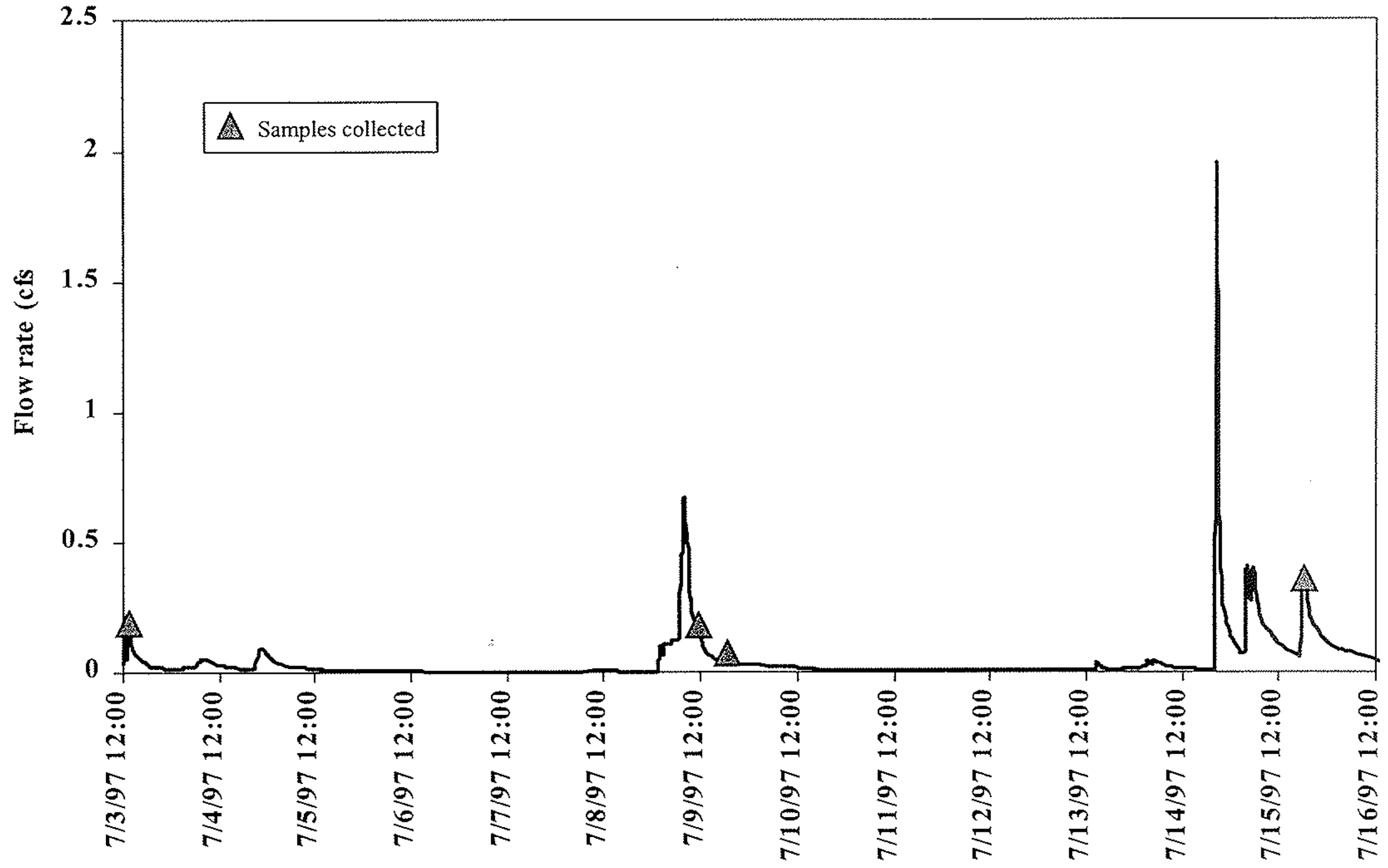

Figure A-4. Flow at Nettle Brook weir 3 – 16 July 1997.

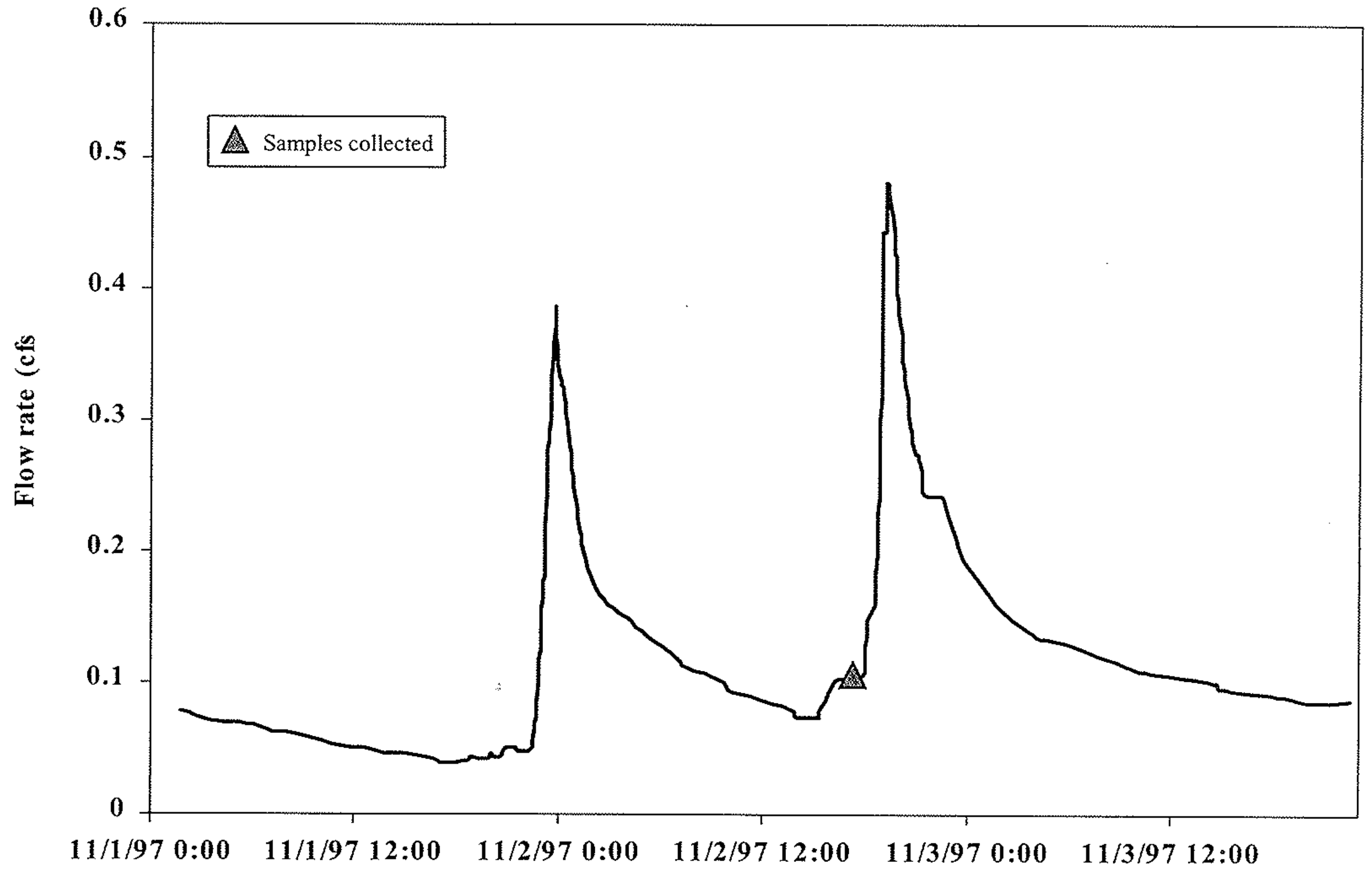

Figure A-6. Flow at Nettle Brook weir 1 – 3 Nov. 1997.

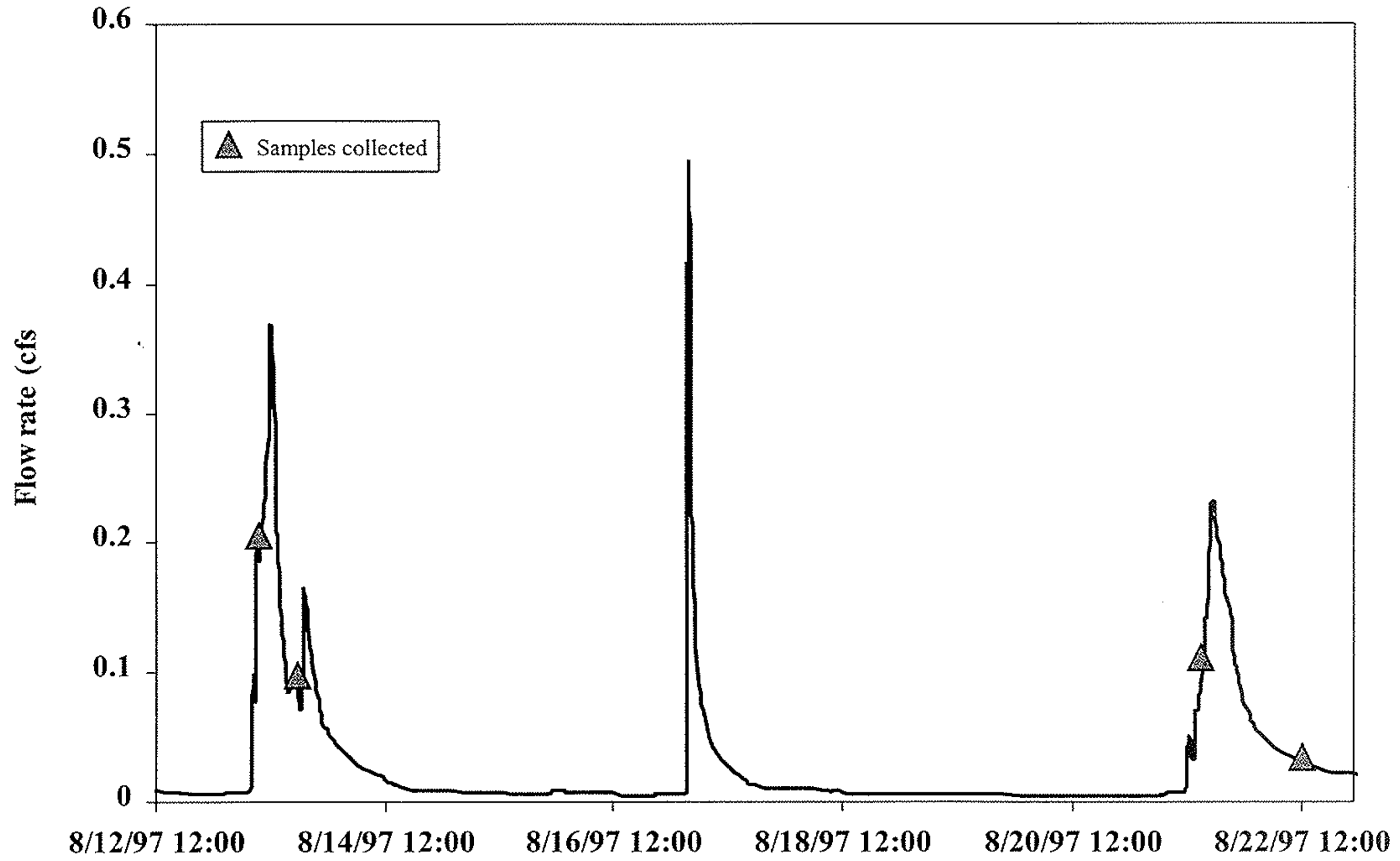

Figure A-5. Flow at Nettle Brook weir 12 – 22 Aug. 1997.

Appendix B

Data Tables

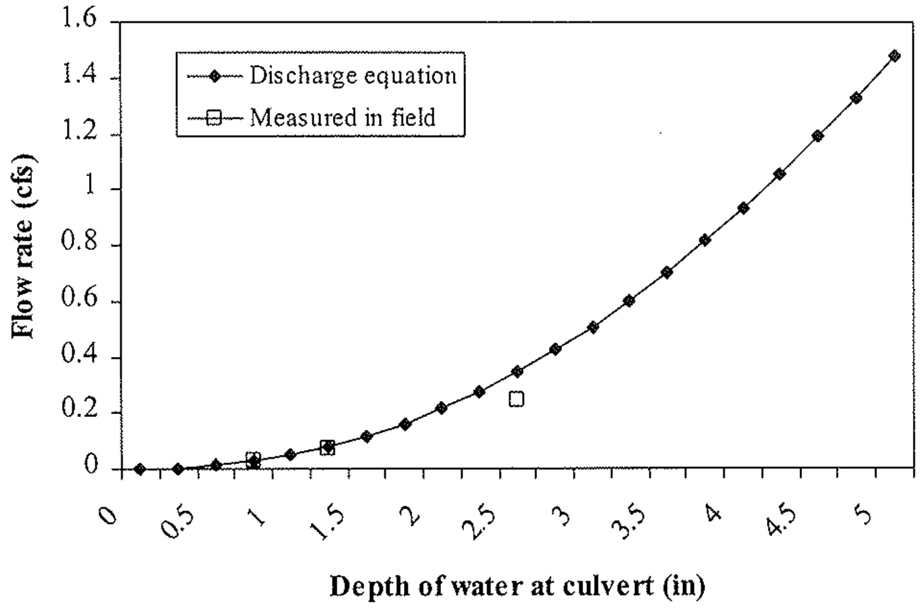

Figure A-7. Flow rate at Stream 10 as calculated using Manning's discharge equation (diamonds) and actual field measurements (squares).

Table B-1. Trace metal concentrations (dry weight basis) in soil samples. Samples collected from pits.

Sample ID	Date collected	Depth (cm)	Soil horizon	Sr 88 (µg g^{-1})	Cd 111 (µg g^{-1})	Ba 137 (µg g^{-1})	La 139 (µg g^{-1})	Ce 140 (µg g^{-1})	Pb 208 (µg g^{-1})
Mid Nettle									
LKC-10S-SOL	12/18/97	5	Oa	2.406	0.051	10.171	0.614	1.257	4.861
LKC-12S-SOL	12/18/97	8	Oa	1.264	0.029	4.744	1.323	4.350	2.989
average				1.835	0.040	7.457	0.968	2.803	3.925
LKC-10D-SOL	12/18/97	23	B	0.840	0.019	3.345	0.929	2.422	0.610
LKC-12D-SOL	12/18/97	23	B	1.239	0.019	4.342	1.596	5.630	0.843
average				1.040	0.019	3.843	1.263	4.026	0.726
Upper Nettle									
LKC-17S-SOL	12/22/97	7	Oa	2.236	0.028	9.779	1.313	2.572	16.373
LKC-16D-SOL	12/22/97	25	B	1.290	0.013	5.301	7.260	7.921	0.971
LKC-17D-SOL	12/22/97	27	B	1.369	0.029	6.339	0.964	6.129	1.424
average				1.329	0.021	5.820	4.112	7.025	1.197
Stream 10									
LKC-13S-SOL	12/19/97	10	Oa	1.414	0.020	5.221	0.596	1.327	8.215
LKC-13D-SOL	12/19/97	25	B	1.403	0.006	5.262	1.492	3.831	1.544
LKC-13D-SOL(lab dup.)	12/19/97	25	B	1.364	0.007	5.096	1.467		1.582
LKC-14D-SOL	12/19/97	22	B	1.921	0.009	3.245	0.971	2.154	1.121
average				1.523	0.007	4.716	1.355	2.992	1.448

Table B-1. Trace metal concentrations (dry weight basis) in soil samples. Samples collected from pits.

Sample ID	Date collected	Depth (cm)	Soil horizon	Hg (ng g^{-1})	Mg 26 (µg g^{-1})	Al 27 (µg g^{-1})	V 51 (µg g^{-1})	Cr 53 (µg g^{-1})	Mn 55 (µg g^{-1})	Ni 60 (µg g^{-1})	Cu 65 (µg g^{-1})	Zn 66 (µg g^{-1})	As 75 (µg g^{-1})	Rb 85 (µg g^{-1})
Mid Nettle														
LKC-10S-SOL	12/18/97	5	Oa	183.9	56.610	366.103	1.395	0.667	13.660	0.470	1.392	4.047	0.236	1.952
LKC-12S-SOL	12/18/97	8	Oa	118.0	240.248	705.846	2.272	1.388	23.750	1.196	1.082	5.854	0.479	1.833
average				151.0	148.429	535.975	1.833	1.027	18.705	0.833	1.237	4.951	0.357	1.892
LKC-10D-SOL	12/18/97	23	B	48.8	238.058	867.469	1.765	1.222	25.092	0.986	0.876	5.412	0.183	1.248
LKC-12D-SOL	12/18/97	23	B	89.0	326.343	997.833	2.334	1.540	33.125	1.389	1.266	6.558	0.227	1.943
average				68.9	282.200	932.651	2.050	1.381	29.108	1.187	1.071	5.985	0.205	1.595
Upper Nettle														
LKC-17S-SOL	12/22/97	7	Oa	309.4	100.083	575.856	3.442	1.261	22.423	0.705	2.530	5.392	0.966	2.386
LKC-16D-SOL	12/22/97	25	B	36.2	336.065	1124.543	2.947	1.878	56.131	1.400	1.610	7.340	0.328	3.057
LKC-17D-SOL	12/22/97	27	B	57.1	244.775	724.827	2.936	1.843	32.347	1.117	1.249	7.064	0.444	4.516
average				46.7	290.420	924.685	2.941	1.860	44.239	1.259	1.430	7.202	0.386	3.786
Stream 10														
LKC-13S-SOL	12/19/97	10	Oa	169.0	65.025	471.271	2.907	0.824	12.332	0.426	0.785	2.978	0.659	1.367
LKC-13D-SOL	12/19/97	25	B	109.8	248.225	1024.397	2.653	1.587	37.323	1.451	1.463	5.025	0.312	2.206
LKC-13D-SOL(lab dup.)	12/19/97	25	B		190.445	811.143	2.414	1.411	34.634	1.355	1.413	4.813	0.298	2.138
LKC-14D-SOL	12/19/97	22	B	39.5	345.974	570.431	2.042	1.049	12.838	1.263	0.845	4.740	0.122	3.326
average				74.7	258.217	857.592	2.441	1.409	30.529	1.380	1.296	4.901	0.261	2.469

Table B-3. Soil water concentrations -- complete data set

Sample ID	Collection date	Sample time	Sample volume	Antecedent dry period (days)	Throughfall (mm)	pH	Conductivity (µ mho)	DOC (mg L⁻¹)	Color (mg L⁻¹ PtCo)	Peak wavelength	Peak absorbance	Hg Conc.† (ng L⁻¹)	Li7 Conc. (µg L⁻¹)	Be9 Conc. (µg L⁻¹)	Mg26 Conc. (µg L⁻¹)	Al27 Conc. (µg L⁻¹)	Ti47 Conc. (µg L⁻¹)	V51 Conc. (µg L⁻¹)
Mid Nettle Shallow Soil Water																		
LKC-148-SSN-MR1	4/21/97	12:15	500	2	21.4	5.35		14.92	295.23	329.5	0.271	17.2	2.72	0.03	222.55	489.23	13.45	0.96
LKC-148-SSN-MR2	4/21/97	12:15	330	2	21.4	5.73		17.81	303.5	330.5	0.293	21.8						
LKC-158-SSN-MR1	6/19/97	9:23	200	6	19.6	6.13		9.47	279.99	330.5	0.313	13.4						
LKC-162-SSN-MR1	7/4/97	14:05	300	6	24.3	5.72	94.3	22.57	358.37	326	0.358	13.0						
LKC-166-SSN-MR1	7/9/97	9:54	500	5	36.9	4.85	84.2	20.91	262.57	330	0.285	14.8	3.20	0.09	832.04	1024.28	10.33	0.77
LKC-166-SSN-MR2	7/10/97	11:20	150	5	36.9	6.57	65.7	20.08				15.8						
LKC-173-SSN-MR1	7/16/97	10:45	300	0.5	11.1	4.68	40.3	28.79	502.49	324	0.542	27.8						
LKC-173-SSN-MR2	7/16/97	10:53	70	0.5	11.1							24.3						
LKC-176-SSN-MR1	8/14/97	10.15	420	3	24.1	5.16	61.1	26.35	354.88	325.5	0.407	19.1	4.91	0.08	689.15	940.46	17.52	1.13
LKC-176-SSN-MR2	8/14/97	10:25	100	3	24.1	6.58	29	16.05				9.3						
LKC-179-SSN-MR1	8/23/97	13:47	280	4	27.5	5.30	46.8	32.20	454.59	322	0.552	26.2						
LKC-190-SSN-MR1	11/3/97	10:30	500	0.5	25.4	4.77	43.2	27.52	464.61	323	0.504	24.1	1.32	0.05	526.48	1142.92	15.46	0.78
LKC-190-SSN-MR2	11/3/97	10:40	300	0.5	25.4	5.80	39.7	36.09	486.38	321	0.563	34.9	5.22	0.02	482.60	901.46	25.74	1.09
Mid Nettle Deep Soil Water																		
LKC-173-DSN-MR1	7/16/97	10.45	110	0.5	11.1	6.06	11.6	2.67				1.9						
LKC-173-DSN-MR2	7/16/97	10:53	70	0.5	11.1							3.0						
LKC-190-DSN-MR1	11/3/97	10:30	100	0.5	25.4	6.97	36.1		19.609	360	0.017	2.6						
LKC-190-DSN-MR2	11/3/97	10:40	145	0.5	25.4	6.93	19.8	2.10				4.5						
Upper Nettle Shallow Soil Water																		
LKC-159-SSN-UR1	6/19/97	9.50	140	6	14.6	6.70		1.69	10.466	350.5	0.011	3.5						
LKC-163-SSN-UR1	7/4/97	14:40	100	6	20.6	6.53	74.4	2.65				3.6						
LKC-167-SSN-UR1	7/9/97	10:30	500	5	36.5	5.85	58.3	2.25	10.466	400	0.044	2.9	2.74	0.08	612.38	56.89	0.82	0.15
LKC-167-SSN-UR2	7/10/97	11:55	75	5	36.5							1.1						
LKC-174-SSN-UR1	7/16/97	11:16	250	0.5	10.5	5.69	26.3	2.87	17.433	360	0.014	4.4						
LKC-177-SSN-UR1	8/14/97	11:00	500	3	20	5.62	22.1	4.51	32.673	350.5	0.025	7.7	1.78	0.10	282.20	115.38	2.62	0.11
LKC-180-SSN-UR1	8/23/97	14:15	250	4	29.9	6.04	27.1	2.74	10.466	351	0.013	3.0						
LKC-191-SSN-UR1	11/3/97	11:05	350	0.5	26.8	5.93	23.5	2.50	13.079	365	0.013	2.7						
LKC-191-SSN-UR2	11/3/97	11:15	500	0.5	26.8	5.47	19.6	1.00	9.1598	364.5	0.01	2.3	1.10	0.06	217.15	100.53	4.45	0.13
Upper Nettle Deep Soil Water																		
LKC-149-DSN-UR2	4/21/97	12:40	400	2	22.4	6.03		0.65	6.5473	393.5	0.008	0.1	1.25	0.05	202.98	24.35	0.33	0.08
LKC-167-DSN-UR1	7/10/97	11:50	175	5	36.5	6.86	53.8	0.95	9.1598	348.5	0.042	0.9						
LKC-167-DSN-UR2	7/10/97	11:55	325	5	36.5	5.99	19.2	0.30	2.6235	427	0.019	0.5						
LKC-174-DSN-UR1	7/16/97	11:16	50	0.5	10.5							1.8						
LKC-174-DSN-UR2	7/16/97	11:25	190	0.5	10.5	5.60	13.9	0.35	9.1598	360	0.147	0.8						
LKC-177-DSN-UR1	8/14/97	11:00	175	3	20	6.63	40.3	1.19	9.1598	411.5	0.007	0.9						
LKC-177-DSN-UR2	8/14/97	11:10	500	3	20	5.61	14.2	0.30	3.4993	412	0.007	0.1	1.02	0.15	177.94	58.31	0.46	0.05
LKC-180-DSN-UR2	8/23/97	14:20	300	4	29.9	5.78	15.2	0.30	5.6764	407	0.005	0.2						
LKC-191-DSN-UR1	11/3/97	11:05	90	0.5	26.8	6.60	34.5		4.8056	397	0.007	5.6						
LKC-191-DSN-UR2	11/3/97	11:15	500	0.5	26.8	5.45	14.2	0.39	3.0639	401.5	0.007	0.4	0.50	0.19	174.94	100.35	0.49	0.02

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-2. Carbon, hydrogen, and nitrogen in soil samples. Samples collected in soil pits on 13 October 1997.

Sample ID	Depth cm	Soil horizon	% C	% H	% N
Mid Nettle					
AD1	11–13.5	Oa	10.88	1.42	0.79
AD10	13.5–24.5	B	2.89	0.54	0.18
AD6	24.5–37.5	BC?	1.42	0.37	0.09
AD11	> 37.5	C	1.29	0.38	0.08
Mid Nettle					
AD3	8–10	Oa	12.48	1.51	0.85
AD9	10–19	E	1.46	0.27	0.13
AD7	19–40	B	2.69	0.53	0.15
Upper Nettle					
AD2	13–22	Oa	10.89	1.50	0.85
AD8	22–27	B	2.60	0.56	0.22
Stream 10					
AD4	27–34	Oa	17.8	2.34	1.19
AD12	40–48	Bh	3.71	0.54	0.20
AD13	48–63	Bhs	2.49	0.46	0.12
AD5	> 63	C	1.17	0.27	0.08

Table B-3. Soil water concentrations -- complete data set

Sample ID	Collection date	Cr53 Conc. (µg L^{-1})	Mn55 Conc. (µg L^{-1})	Co59 Conc. (µg L^{-1})	Ni60 Conc. (µg L^{-1})	Cu65 Conc. (µg L^{-1})	Zn66 Conc. (µg L^{-1})	As75 Conc. (µg L^{-1})	Rb85 Conc. (µg L^{-1})	Sr88 Conc. (µg L^{-1})	Mo95 Conc. (µg L^{-1})	Ag107 Conc. (µg L^{-1})	Cd111 Conc. (µg L^{-1})	In115 Conc. (µg L^{-1})	Sb121 Conc. (µg L^{-1})	Ba137 Conc. (µg L^{-1})	La139 Conc. (µg L^{-1})	Ce140 Conc. (µg L^{-1})	Nd146 Conc. (µg L^{-1})	Sm147 Conc. (µg L^{-1})
Mid Nettle Shallow Soil Water																				
LKC-148-SSN-MR1	4/21/97	0.37	56.18	0.26	1.34	1.48	12.27	0.27	3.92	16.53	0.02	0.00	0.11	0.00	0.00	13.75	0.44	0.80	0.31	0.06
LKC-148-SSN-MR2	4/21/97																			
LKC-158-SSN-MR1	6/19/97																			
LKC-162-SSN-MR1	7/4/97																			
LKC-166-SSN-MR1	7/9/97	0.54	248.97	0.97	4.49	1.44	48.92	0.29	11.58	63.93	0.02	0.00	0.78	0.00	0.09	68.68	0.44	0.84	0.39	0.08
LKC-166-SSN-MR2	7/10/97																			
LKC-173-SSN-MR1	7/16/97																			
LKC-173-SSN-MR2	7/16/97																			
LKC-176-SSN-MR1	8/14/97	0.68	193.18	0.84	3.73	2.10	35.77	0.35	8.65	57.08	0.03	0.00	0.53	0.00	0.07	43.51	0.54	1.06	0.45	0.11
LKC-176-SSN-MR2	8/14/97																			
LKC-179-SSN-MR1	8/23/97																			
LKC-190-SSN-MR1	11/3/97	0.42	145.48	0.54	2.40	1.45	28.16	0.21	2.89	31.57	0.03	0.01	0.33	0.00	0.04	39.58	0.45	0.86	0.38	0.08
LKC-190-SSN-MR2	11/3/97	1.02	23.29	0.22	1.97	2.36	11.67	0.27	1.85	32.20	0.03	0.01	0.11	0.00	0.11	4.06	0.66	1.16	0.53	0.11
Mid Nettle Deep Soil Water																				
LKC-173-DSN-MR1	7/16/97																			
LKC-173-DSN-MR2	7/16/97																			
LKC-190-DSN-MR1	11/3/97																			
LKC-190-DSN-MR2	11/3/97																			
Upper Nettle Shallow Soil Water																				
LKC-159-SSN-UR1	6/19/97																			
LKC-163-SSN-UR1	7/4/97																			
LKC-167-SSN-UR1	7/9/97	0.15	31.12	0.06	4.21	0.61	53.62	0.06	7.88	55.91	0.01	0.00	0.21	0.00	0.01	13.71	0.65	0.39	0.50	0.10
LKC-167-SSN-UR2	7/10/97																			
LKC-174-SSN-UR1	7/16/97																			
LKC-177-SSN-UR1	8/14/97	0.18	24.44	0.06	2.36	0.85	30.02	0.09	3.62	28.43	0.01	0.01	0.10	0.00	0.01	10.98	2.70	1.37	1.89	0.33
LKC-180-SSN-UR1	8/23/97																			
LKC-191-SSN-UR1	11/3/97																			
LKC-191-SSN-UR2	11/3/97	0.08	41.35	0.11	1.55	0.45	14.78	0.05	0.88	12.10	0.00	0.00	0.17	0.00	0.00	10.94	2.89	0.77	2.13	0.42
Upper Nettle Deep Soil Water																				
LKC-149-DSN-UR2	4/21/97	0.02	17.20	0.05	1.83	0.25	24.09	0.02	0.16	18.16	0.00	0.00	0.12	0.00	0.00	0.43	3.89	0.05	0.97	0.10
LKC-167-DSN-UR1	7/10/97																			
LKC-167-DSN-UR2	7/10/97																			
LKC-174-DSN-UR1	7/16/97																			
LKC-174-DSN-UR2	7/16/97																			
LKC-177-DSN-UR1	8/14/97																			
LKC-177-DSN-UR2	8/14/97	0.07	13.08	0.04	1.46	0.60	14.72	0.07	0.77	9.39	0.00	0.00	0.11	0.00	0.00	13.35	27.93	0.45	13.31	1.69
LKC-180-DSN-UR2	8/23/97																			
LKC-191-DSN-UR1	11/3/97																			
LKC-191-DSN-UR2	11/3/97	0.06	8.85	0.04	1.40	0.57	14.93	0.07	0.52	7.43	0.00	0.00	0.11	0.00	0.00	15.36	27.42	0.26	16.82	2.46

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-3. Soil water concentrations -- complete data set

Sample ID	Collection date	Sample time	Sample volume	Antecedent dry period (days)	Throughfall (mm)	pH	Conductivity (µ mho)	DOC (mg L^{-1})	Color (mg L^{-1} PtCo)	Peak wavelength	Peak absorbance	Hg Conc.† (ng L^{-1})	Li7 Conc. (µg L^{-1})	Be9 Conc. (µg L^{-1})	Mg26 Conc. (µg L^{-1})	Al27 Conc. (µg L^{-1})	Ti47 Conc. (µg L^{-1})	V51 Conc. (µg L^{-1})
Stream 10 Shallow Soil Water																		
LKC-160-SST-1R1	6/19/97	11:45	500	6	22	4.27		15.86	140.66	332.5	0.162	12.2	0.93	0.08	189.37	1598.41	6.17	0.69
LKC-164-SST-1R1	7/3/97	18:45	500	6	19.6	4.99	35.1	13.78	121.06	348.5	0.178	15.3	2.56	0.02	153.50	554.05	8.84	0.78
LKC-187-SST-1R1	9/20/97	14:50	230	3	17	5.49	22.6	26.11	264.75	326	0.328	29.4						
LKC-188-SST-1R1	9/24/97	15:35	230	3	17	4.77	23.3	20.88	179.41	330.5	0.228	15.4						
LKC-192-SST-1R1	11/2/97	14:55	500	0.5	14	4.22	36.4	22.18	263.45	330.5	0.281	19.5	0.34	0.04	52.10	1509.15	7.96	0.72
LKC-164-SST-1R2	7/4/97	15:50	500	6	12.9	4.53	46.2	13.80	119.32	338.5	0.142	7.7						
Stream 10 Deep Soil Water																		
LKC-160-DST-1R1	6/19/97	11:45	500	6	22	5.24		5.63	43.993	351	0.046	7.8	5.68	0.05	304.52	518.46	5.95	0.42
LKC-164-DST-1R1	7/4/97	15:50	75	6	32.5							2.5						
LKC-188-DST-1R1	9/24/97	15:35	240	3	17	4.88	25.4	16.67	37.462	351	0.05	5.9						
LKC-192-DST-1R1	11/2/97	14:55	500	0.5	14	4.57	22.8	11.46	88.406	344.5	0.098	10.2	1.56	0.02	88.69	781.75	4.44	0.28
Mid Nettle Shallow Soil Water - FILTERED																		
LKC -148-SSN -MF1	4/21/97	12:15	500	2	21.4	5.35		14.92	295.23	329.5	0.271	14.5	2.69	0.02	220.85	470.81	11.14	0.88
LKC -166-SSN -MF1	7/9/97	9:54	500	5	36.9	4.85	84.2	20.91	262.57	330	0.285	12.7	3.12	0.08	798.84	973.20	9.50	0.72
LKC -176-SSN -MF1	8/14/97	10:15	420	3	24.1	5.16	61.1	26.35	354.88	325.5	0.407	17.1						
LKC -190-SSN -MF1	11/3/97	10:30	500	0.5	25.4	4.77	43.2	27.52	464.61	323	0.504	17.5	1.34	0.08	551.23	1166.36	14.21	0.75
LKC -148-SSN -MF2	4/21/97	12:15	330	2	21.4	5.73		17.81	303.5	330.5	0.293	11.4						
Upper Nettle Shallow Soil Water - FILTERED																		
LKC -167-SSN -UF1	7/9/97	10:30	500	5	36.5	5.85	58.3	2.25	10.466	400	0.044	2.9	2.84	0.09	637.64	54.58	0.81	0.15
LKC -177-SSN -UF1	8/14/97	11:00	500	3	20	5.62	22.1	4.51	32.673	350.5	0.025	2.8	1.75	0.09	278.67	99.20	1.96	0.11
LKC -191-SSN -UF2	11/3/97	11:15	500	0.5	26.8	5.47	19.6	1.00	9.1598	364.5	0.01	1.1	1.08	0.04	209.06	51.98	0.61	0.06
Upper Nettle Deep Soil Water - FILTERED																		
LKC -149-DSN -UF2	4/21/97	12:40	400	2	22.4	6.03		0.65	6.5473	393.5	0.008	0.1	1.26	0.06	206.81	20.83	0.28	0.09
LKC -177-DSN -UF2	8/14/97	11:10	500	3	20	5.61	14.2	0.30	3.4993	412	0.007	0.1	1.00	0.16	175.68	56.42	0.32	0.05
LKC -191-DSN -UF2	11/3/97	11:05	500	0.5	26.8	5.45	14.2	0.39	3.0639	401.5	0.007	0.8	0.47	0.22	182.48	102.11	0.40	0.02
Stream 10 Shallow Soil Water - FILTERED																		
LKC -160-SST -1F1	6/19/97	11:45	500	6	22	4.27		15.86	140.66	332.5	0.162	8.1	0.97	0.07	192.83	1611.09	5.22	0.72
LKC -164-SST -1F1	7/3/97	18:45	500	6	19.6	4.99	35.1	13.78	121.06	348.5	0.178	10.6						
LKC -192-SST -1F1	11/2/97	14:55	500	0.5	14	4.22	36.4	22.18	263.45	330.5	0.281	11.7	0.30	0.07	52.61	1419.97	6.01	0.70
LKC -164-SST -1F2	7/4/97	15:50	500	6	12.9	4.53	46.2	13.80	119.32	338.5	0.142	7.7						
Stream 10 Deep Soil Water - FILTERED																		
LKC -160-DST -1F1	6/19/97	11:45	500	6	22	5.24		5.63	43.993	351	0.046	4.0	5.61	0.05	310.33	451.24	3.26	0.37
LKC -192-DST -1F1	11/2/97	14:55	500	0.5	14	4.57	22.8	11.46	88.406	344.5	0.098	6.4	1.58	0.04	89.20	786.18	3.39	0.26

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-3. Soil water concentrations -- complete data set

Sample ID	Collection date	W182 Conc. (μg L⁻¹)	Tl205 Conc. (μg L⁻¹)	Pb208 Conc. (μg L⁻¹)	Cl (mg L⁻¹)	NO_3–N (mg L⁻¹)	NH_4–N (mg L⁻¹)	Ca (mg L⁻¹)	K (mg L⁻¹)	Mg (mg L⁻¹)	Na (mg L⁻¹)	SO_4–S (mg L⁻¹)	Si (mg L⁻¹)
Mid Nettle Shallow Soil Water													
LKC-148-SSN-MR1	4/21/97	0.00	0.02	1.13	0.25	0.923	0.025	3.52	1.31	0.16	0.35	0.42	0.94
LKC-148-SSN-MR2	4/21/97				0.46	1.491	0.012	4.81	1.84	0.37	0.45	0.86	1.05
LKC-158-SSN-MR1	6/19/97				0.41	12.285	0.001	18.32	2.87	1.17	1.04	1.41	7.67
LKC-162-SSN-MR1	7/4/97				0.21	7.638	0.038	12.83	3.08	0.91	0.48	1.41	4.51
LKC-166-SSN-MR1	7/9/97	0.00	0.05	0.70	0.21	7.67	0.025	10.96	3.09	0.98	0.57	1.95	2.94
LKC-166-SSN-MR2	7/10/97												
LKC-173-SSN-MR1	7/16/97				0.14	2.72	0.01	4.93	1.99	0.41	0.16	1.38	1.73
LKC-173-SSN-MR2	7/16/97												
LKC-176-SSN-MR1	8/14/97	0.00	0.04	1.08	0.21	4.842	0.009	9.32	2.14	0.73	0.24	1.18	4.22
LKC-176-SSN-MR2	8/14/97												
LKC-179-SSN-MR1	8/23/97				0.18	2.995	0.022	7.35	1.6	0.53	0.28	0.96	5.32
LKC-190-SSN-MR1	11/3/97	0.00	0.02	0.94	0.95	2.16	0.018	5.44	0.98	0.58	0.31	1.11	1.30
LKC-190-SSN-MR2	11/3/97	0.00	0.01	1.51	0.34	0.133	0.015	7.41	0.91	0.58	0.43	1.94	3.56
Mid Nettle Deep Soil Water													
LKC-173-DSN-MR1	7/16/97												
LKC-173-DSN-MR2	7/16/97												
LKC-190-DSN-MR1	11/3/97												
LKC-190-DSN-MR2	11/3/97												
Upper Nettle Shallow Soil Water													
LKC-159-SSN-UR1	6/19/97				0.28	0.965	0.064	10.4	1.23	0.68	0.76	0.58	3.84
LKC-163-SSN-UR1	7/4/97												
LKC-167-SSN-UR1	7/9/97	0.00	0.00	0.01	0.35	5.261	0.02	7.35	2.04	0.68	0.33	1.82	1.83
LKC-167-SSN-UR2	7/10/97												
LKC-174-SSN-UR1	7/16/97				0.18	1.331	0.001	3.4	1.27	0.29	0.17	2.08	1.03
LKC-177-SSN-UR1	8/14/97	0.00	0.00	0.08	0.18	2.091	0.008	3.56	1	0.29	0.14	1.89	1.41
LKC-180-SSN-UR1	8/23/97				0.18	1.111	0.008	3.71	0.89	0.29	0.16	1.82	1.98
LKC-191-SSN-UR1	11/3/97				0.36	0.27	0.001	3.19	0.65	0.28	0.33	1.29	1.07
LKC-191-SSN-UR2	11/3/97	0.00	0.00	0.23	0.36	0.352	0.001	1.87	0.65	0.24	0.40	1.48	0.85
Upper Nettle Deep Soil Water													
LKC-149-DSN-UR2	4/21/97	0.00	0.00	0.02	0.43	0.556	0.001	2.2	0.39	0.17	0.37	1.31	0.8
LKC-167-DSN-UR1	7/10/97				0.28	3.927	0.001	9.51	0.71	0.42	0.96	0.73	3.91
LKC-167-DSN-UR2	7/10/97				0.35	0.192	0.001	2.18	0.69	0.22	0.51	1.54	1.16
LKC-174-DSN-UR1	7/16/97				0.35	0.235	0.022	1.56	0.65	0.21	0.38	1.57	1.06
LKC-174-DSN-UR2	7/16/97												
LKC-177-DSN-UR1	8/14/97				0.25	2.581	0.001	5.97	1.05	0.3	0.49	1.12	2.9
LKC-177-DSN-UR2	8/14/97	0.01	0.00	0.00	0.35	0.001	0.008	1.33	0.6	0.19	0.26	1.63	0.97
LKC-180-DSN-UR2	8/23/97				0.35	0.005	0.001	1.75	0.56	0.21	0.24	1.44	1.32
LKC-191-DSN-UR1	11/3/97												
LKC-191-DSN-UR2	11/3/97	0.00	0.00	0.01	0.33	0.027	0.042	1.16	0.56	0.21	0.33	1.44	0.44

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-3. Soil water concentrations -- complete data set

Sample ID	Collection date	Cr53 Conc. (μg L⁻¹)	Mn55 Conc. (μg L⁻¹)	Co59 Conc. (μg L⁻¹)	Ni60 Conc. (μg L⁻¹)	Cu65 Conc. (μg L⁻¹)	Zn66 Conc. (μg L⁻¹)	As75 Conc. (μg L⁻¹)	Rb85 Conc. (μg L⁻¹)	Sr88 Conc. (μg L⁻¹)	Mo95 Conc. (μg L⁻¹)	Ag107 Conc. (μg L⁻¹)	Cd111 Conc. (μg L⁻¹)	In115 Conc. (μg L⁻¹)	Sb121 Conc. (μg L⁻¹)	Ba137 Conc. (μg L⁻¹)	La139 Conc. (μg L⁻¹)	Ce140 Conc. (μg L⁻¹)	Nd146 Conc. (μg L⁻¹)	Sm147 Conc. (μg L⁻¹)
Mid Nettle Shallow Soil Water *Stream 10 Shallow Soil Water*																				
LKC-160-SST-1R1	6/19/97	0.41	34.62	0.68	2.39	1.70	14.22	0.22	10.10	11.13	0.03	0.00	0.23	0.00	0.07	14.43	1.51	2.90	1.42	0.27
LKC-164-SST-1R1	7/3/97	0.29	28.77	0.37	1.32	1.96	8.54	0.18	13.35	12.70	0.03	0.00	0.11	0.00	0.02	6.33	1.14	2.08	0.94	0.18
LKC-187-SST-1R1	9/20/97																			
LKC-188-SST-1R1	9/24/97																			
LKC-192-SST-1R1	11/2/97	0.26	14.86	0.36	1.18	1.85	5.04	0.22	1.48	3.34	0.03	0.00	0.13	0.00	0.06	7.16	2.12	4.19	1.98	0.39
LKC-164-SST-1R2	7/4/97																			
Stream 10 Deep Soil Water																				
LKC-160-DST-1R1	6/19/97	0.48	43.17	0.71	1.40	1.21	22.53	0.16	2.16	21.61	0.02	0.00	0.14	0.00	0.02	4.78	0.77	1.57	0.78	0.16
LKC-164-DST-1R1	7/4/97																			
LKC-188-DST-1R1	9/24/97																			
LKC-192-DST-1R1	11/2/97	0.39	20.12	0.38	0.72	1.31	58.86	0.18	1.79	5.36	0.00	0.00	0.09	0.00	0.00	5.99	1.18	2.24	1.23	0.25
Mid Nettle Shallow Soil Water - FILTERED																				
LKC -148-SSN -MF1	4/21/97	0.38	55.79	0.26	1.37	1.60	13.08	0.27	3.77	16.45	0.03	0.00	0.14	0.00	0.00	13.64	0.42	0.75	0.31	0.06
LKC -166-SSN -MF1	7/9/97	0.49	239.37	0.97	4.30	1.34	47.22	0.28	11.28	61.93	0.03	0.00	0.76	0.00	0.09	66.23	0.42	0.80	0.38	0.08
LKC -176-SSN -MF1	8/14/97																			
LKC -190-SSN -MF1	11/3/97	0.37	152.22	0.56	2.49	1.40	28.52	0.20	2.92	32.39	0.06	0.00	0.37	0.01	0.09	39.70	0.44	0.84	0.38	0.08
LKC -148-SSN -MF2	4/21/97																			
Upper Nettle Shallow Soil Water - FILTERED																				
LKC -167-SSN -UF1	7/9/97	0.16	32.60	0.05	4.38	0.62	54.55	0.07	8.00	57.61	0.01	0.00	0.21	0.00	0.03	13.95	0.63	0.38	0.50	0.09
LKC -177-SSN -UF1	8/14/97	0.21	23.71	0.06	2.44	0.75	30.54	0.10	3.61	28.21	0.01	0.01	0.12	0.00	0.03	10.88	2.28	1.19	1.69	0.31
LKC -191-SSN -UF2	11/3/97	0.02	28.84	0.06	1.40	0.33	13.87	0.03	0.84	11.62	0.01	0.00	0.17	0.00	0.00	10.32	1.78	0.11	1.16	0.21
Upper Nettle Deep Soil Water - FILTERED																				
LKC -149-DSN -UF2	4/21/97	0.05	17.12	0.05	1.91	0.24	24.34	0.03	0.16	18.08	0.00	0.00	0.13	0.00	0.00	0.46	3.62	0.04	0.80	0.07
LKC -177-DSN -UF2	8/14/97	0.08	12.97	0.04	1.41	0.56	14.52	0.06	0.76	9.32	0.03	0.00	0.13	0.01	0.03	13.09	27.47	0.45	13.09	1.67
LKC -191-DSN -UF2	11/3/97	0.05	9.08	0.04	1.41	0.62	15.04	0.09	0.52	7.57	0.07	0.00	0.12	0.03	0.09	15.54	27.61	0.26	16.91	2.51
Stream 10 Shallow Soil Water - FILTERED																				
LKC -160-SST -1F1	6/19/97	0.34	35.53	0.71	2.43	1.75	14.58	0.23	10.32	11.51	0.06	0.00	0.23	0.02	0.18	14.77	1.48	2.86	1.44	0.28
LKC -164-SST -1F1	7/3/97																			
LKC -192-SST -1F1	11/2/97	0.23	15.65	0.37	1.29	1.65	5.67	0.24	1.53	3.46	0.03	0.00	0.13	0.00	0.08	7.31	1.93	3.91	1.89	0.36
LKC -164-SST -1F2	7/4/97																			
Stream 10 Deep Soil Water - FILTERED																				
LKC -160-DST -1F1	6/19/97	0.39	43.80	0.71	1.39	1.12	26.01	0.16	2.13	21.45	0.03	0.00	0.15	0.01	0.07	4.64	0.70	1.36	0.73	0.14
LKC -192-DST -1F1	11/2/97	0.44	21.07	0.38	0.81	1.28	61.11	0.17	1.79	5.81	0.01	0.00	0.10	0.00	0.02	6.14	1.16	2.23	1.22	0.23

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Sample time	Stream flow (cfs)	Nettle flow (mm hr^{-1})	H$_2$O temp (C)	pH	Conductivity (μ mho)	DOC (mg L^{-1})	Color (mg L^{-1} PtCo)	Peak wavelength	Peak absorbance	Hg Conc.† (ng L^{-1})	Li7 Conc. (μg L^{-1})	Be9 Conc. (μg L^{-1})	Mg26 Conc. (μg L^{-1})	Al27 Conc. (μg L^{-1})	Ti47 Conc. (μg L^{-1})
Nettle Brook Weir																	
LKC-144-STN-WR1	4/12/97	17:00	0.102	0.094	1.3	5.88		1.50	12.208	360	0.012	1.0					
LKC-147-STN-WR1	4/20/97	11:55	0.120	0.111	4.2	6.14		1.71	16.997	350.5	0.016	1.7	0.28	0.01	245.03	49.08	1.44
LKC-147-STN-WR2	4/20/97	15:20	0.250	0.232	6.1	6.09		2.35	27.447	350.5	0.025	2.5	0.36	0.02	238.24	81.87	2.56
LKC-157-STN-WR1	6/18/97	18:25	0.069	0.064	12.3	6.28		3.73	45.299	351	0.039	3.0	0.27	0.04	326.87	74.59	2.59
LKC-161-STN-WR1	7/3/97	17:02	0.039	0.036	15.1	6.31	25.6	4.12	45.299	351	0.041	2.9	0.35	0.02	391.30	68.05	1.68
LKC-165-STN-WR1	7/9/97	9:28	0.272	0.252	13.5	5.96	17.9	6.18	62.716	344	0.063	4.5	0.43	0.04	245.94	168.25	4.30
LKC-165-STN-WR2	7/9/97	15:29	0.049	0.046	13.4	6.20	19.8	3.76	37.898	351	0.036	2.8	0.35	0.04	269.23	69.12	1.19
LKC-172-STN-WR1	7/15/97	17:43	0.308	0.286	16.3	6.15	17.2	4.67	62.281	344	0.067	9.2	0.52	0.05	292.34	233.51	11.14
LKC-175-STN-WR1	8/13/97	9:45	0.185	0.172	14.3	6.14	24.4	5.80	70.119	340	0.059	4.8	0.37	0.05	295.45	138.39	4.27
LKC-175-STN-WR2	8/13/97	15:19	0.098	0.091	14.2	6.21	15.4	4.94	48.783	344.5	0.049	3.8	0.36	0.04	241.29	95.61	1.89
LKC-178-STN-WR1	8/21/97	15:15	0.104	0.096	12.7	6.15	17.2	5.60	65.329	344	0.062	5.9	0.33	0.04	263.10	156.49	5.83
LKC-178-STN-WR2	8/22/97	10:05	0.033	0.031	12.9	6.31	19.8	2.96	28.318	350.5	0.029	1.8	0.31	0.02	312.76	55.08	1.09
LKC-189-STN-WR1	11/2/97	16:30	0.103	0.095	8.9	5.88	17.4	3.29	47.477	351	0.04	2.8	0.38	0.03	271.90	65.28	1.09
Nettle Brook Weir -- FILTERED																	
LKC -144-STN -WF1	4/12/97	17:00	0.102	0.094	1.3	5.88		1.50	12.208	360	0.012	1.0	0.27	0.03	263.89	37.86	0.42
LKC -147-STN -WF1	4/20/97	11:55	0.120	0.111	4.2	6.14		1.71	16.997	350.5	0.016	1.0	0.28	0.01	255.15	38.87	0.44
LKC -147-STN -WF2	4/20/97	15:20	0.250	0.232	6.1	6.09		2.35	27.447	350.5	0.025	1.3	0.32	0.02	222.21	51.17	0.49
LKC -157-STN -WF1	6/18/97	18:25	0.069	0.064	12.3	6.28		3.73	45.299	351	0.039	2.6	0.28	0.03	321.94	46.94	0.88
LKC -161-STN -WF1	7/3/97	17:02	0.039	0.036	15.1	6.31	25.6	4.12	45.299	351	0.041	2.7	0.36	0.01	409.12	60.05	1.11
LKC -165-STN -WF1	7/9/97	9:28	0.272	0.252	13.5	5.96	17.9	6.18	62.716	344	0.063	1.5	0.40	0.02	232.43	100.22	0.79
LKC -165-STN -WF2	7/9/97	15:29	0.049	0.046	13.4	6.20	19.8	3.76	37.898	351	0.036	2.0	0.33	0.03	259.99	56.64	0.64
LKC -172-STN -WF1	7/15/97	17:43	0.308	0.286	16.3	6.15	17.2	4.67	62.281	344	0.067	3.5	0.36	0.02	257.57	72.55	1.00
LKC -175-STN -WF1	8/13/97	9:45	0.185	0.172	14.3	6.14	24.4	5.80	70.119	340	0.059	3.1	0.35	0.02	317.36	101.14	1.41
LKC -175-STN -WF2	8/13/97	15:19	0.098	0.091	14.2	6.21	15.4	4.94	48.783	344.5	0.049	3.0	0.36	0.02	238.16	76.77	0.81
LKC -178-STN -WF1	8/21/97	15:15	0.104	0.096	12.7	6.15	17.2	5.60	65.329	344	0.062	3.0	0.27	0.02	264.38	84.72	1.21
LKC -178-STN -WF2	8/22/97	10:05	0.033	0.031	12.9	6.31	19.8	2.96	28.318	350.5	0.029	1.8	0.29	0.02	310.46	47.00	0.73
LKC -189-STN -WF1	11/2/97	16:30	0.103	0.095	8.9	5.88	17.4	3.29	47.477	351	0.04	2.5	0.36	0.02	275.28	62.35	0.75
Mid Nettle Brook																	
LKC-145-STN-MR1	4/12/97	17:28	0.102	0.094	1.2	5.42		1.68	10.902	360	0.01	0.9	0.33	0.04	216.19	64.82	0.72
LKC-148-STN-MR1	4/20/97	12:30	0.151	0.140	5.1	5.54		1.99	16.997	350.5	0.019	2.3	0.35	0.02	191.85	81.97	1.26
LKC-148-STN-MR2	4/20/97	15:45	0.249	0.231	6.2	5.10		2.22	25.706	350.5	0.022	2.1	0.35	0.01	190.51	83.57	1.10
LKC-158-STN-MR1	6/18/97	18:45	0.068	0.063	12.3	5.54		4.08	45.299	349.5	0.051	3.0	0.40	0.03	191.26	114.75	1.63
LKC-162-STN-MR1	7/3/97	17:21	0.037	0.034	15.0	5.59	19.4	4.88	45.299	350.5	0.046	3.3	0.54	0.05	249.52	130.93	1.05
LKC-166-STN-MR1	7/9/97	9:45	0.242	0.224	13.5	5.65	15.7	5.99	61.846	340	0.059	4.1	0.40	0.07	207.17	144.48	1.45
LKC-166-STN-MR2	7/9/97	15:47	0.048	0.044	13.4	5.63	15	4.32	36.156	350.5	0.041	2.8	0.45	0.04	211.68	114.64	0.86
LKC-173-STN-MR1	7/15/97	17:58	0.343	0.318	16.3	5.43	12.2	4.23	45.299	360	0.038	4.6	0.48	0.07	198.51	168.51	2.38
LKC-176-STN-MR1	8/13/97	10:07	0.207	0.192	14.3	5.61	12.8	6.64	79.698	344	0.071	5.0	0.45	0.06	210.93	158.91	1.66
LKC-176-STN-MR2	8/13/97	15:35	0.091	0.084	14.2	5.63	11.9	4.92	45.735	350.5	0.048	3.9	0.42	0.04	176.19	118.94	0.94
LKC-179-STN-MR1	8/21/97	15:30	0.118	0.110	12.7	5.80	12.3	6.05	67.942	340	0.062	4.2	0.34	0.05	153.34	126.53	1.56
LKC-179-STN-MR2	8/22/97	10:20	0.033	0.030	12.9	5.26	12.5	3.34	28.318	350.5	0.031	2.4	0.45	0.03	166.31	90.55	0.72
LKC-190-STN-MR1	11/2/97	16:55	0.104	0.096	8.9	5.77	15.8	3.14	40.075	350.5	0.037	2.5	0.45	0.03	220.00	84.65	0.76

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-3. Soil water concentrations -- complete data set

Sample ID	Collection date	W182 Conc. (μg L^{-1})	Tl205 Conc. (μg L^{-1})	Pb208 Conc. (μg L^{-1})	Cl (mg L^{-1})	NO$_3$–N (mg L^{-1})	NH$_4$–N (mg L^{-1})	Ca (mg L^{-1})	K (mg L^{-1})	Mg (mg L^{-1})	Na (mg L^{-1})	SO$_4$–S (mg L^{-1})	Si (mg L^{-1})
Stream 10 Shallow Soil Water													
LKC-160-SST-1R1	6/19/97	0.01	0.04	1.02	1.71	3.116	0.027	1.62	3	0.15	0.47	1.48	0.43
LKC-164-SST-1R1	7/3/97	0.01	0.06	1.34	1.17	1.591	0.286	2.72	3.04	0.1	0.67	1.31	0.8
LKC-187-SST-1R1	9/20/97				0.35	0.041	0.12	3.95	0.75	0.15	0.51	0.92	2.70
LKC-188-SST-1R1	9/24/97				0.33	0.055	0.055	2.44	0.80	0.12	0.38	1.47	0.81
LKC-192-SST-1R1	11/2/97	0.00	0.02	3.31	0.55	0.323	0.019	0.46	0.76	0.07	0.31	1.03	0.13
LKC-164-SST-1R2	7/4/97				0.96	3.026	0.075	2.06	3.1	0.1	0.28	1.54	0.55
Stream 10 Deep Soil Water													
LKC-160-DST-1R1	6/19/97	0.00	0.02	0.26	0.46	3.528	0.01	3.93	1.2	0.29	0.63	1.71	1.71
LKC-164-DST-1R1	7/4/97												
LKC-188-DST-1R1	9/24/97				0.54	0.063	0.011	2.38	0.97	0.22	0.46	2.34	1.58
LKC-192-DST-1R1	11/2/97	0.00	0.02	0.76	0.44	0.129	0.011	0.80	1.00	0.13	0.35	1.25	0.48
Mid Nettle Shallow Soil Water - FILTERED													
LKC -148-SSN -MF1	4/21/97	0.00	0.02	1.10	0.25	0.923	0.025	3.52	1.31	0.16	0.35	0.42	0.94
LKC -166-SSN -MF1	7/9/97	0.00	0.05	0.67	0.21	7.67	0.025	10.96	3.09	0.98	0.57	1.95	2.94
LKC -176-SSN -MF1	8/14/97				0.21	4.842	0.009	9.32	2.14	0.73	0.24	1.18	4.22
LKC -190-SSN -MF1	11/3/97	0.04	0.02	0.88	0.95	2.16	0.018	5.44	0.98	0.58	0.31	1.11	1.30
LKC -148-SSN -MF2	4/21/97				0.46	1.491	0.012	4.81	1.84	0.37	0.45	0.86	1.05
Upper Nettle Shallow Soil Water - FILTERED													
LKC -167-SSN -UF1	7/9/97	0.00	0.01	0.01	0.35	5.261	0.02	7.35	2.04	0.68	0.33	1.82	1.83
LKC -177-SSN -UF1	8/14/97	0.01	0.00	0.06	0.18	2.091	0.008	3.56	1	0.29	0.14	1.89	1.41
LKC -191-SSN -UF2	11/3/97	0.02	0.00	0.02	0.36	0.27	0.001	3.19	0.65	0.28	0.33	1.29	1.07
Upper Nettle Deep Soil Water - FILTERED													
LKC -149-DSN -UF2	4/21/97	0.00	0.00	0.01	0.43	0.556	0.001	2.2	0.39	0.17	0.37	1.31	0.8
LKC -177-DSN -UF2	8/14/97	0.06	0.00	0.01	0.35	0.001	0.008	1.33	0.6	0.19	0.26	1.63	0.97
LKC -191-DSN -UF2	11/3/97	0.13	0.01	0.01	0.33	0.027	0.042	1.16	0.56	0.21	0.33	1.44	0.44
Stream 10 Shallow Soil Water - FILTERED													
LKC -160-SST -1F1	6/19/97	0.09	0.05	0.98	1.71	3.116	0.027	1.62	3	0.15	0.47	1.48	0.43
LKC -164-SST -1F1	7/3/97				1.17	1.591	0.286	2.72	3.04	0.1	0.67	1.31	0.8
LKC -192-SST -1F1	11/2/97	0.02	0.02	2.98	0.55	0.323	0.019	0.46	0.76	0.07	0.31	1.03	0.13
LKC -164-SST -1F2	7/4/97				0.96	3.026	0.075	2.06	3.1	0.1	0.28	1.54	0.55
Stream 10 Deep Soil Water - FILTERED													
LKC -160-DST -1F1	6/19/97	0.05	0.02	0.16	0.46	3.528	0.01	3.93	1.2	0.29	0.63	1.71	1.71
LKC -192-DST -1F1	11/2/97	0.01	0.02	0.68	0.44	0.129	0.011	0.80	1.00	0.13	0.35	1.25	0.48

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Sample time	Stream flow (cfs)	Nettle flow (mm hr⁻¹)	H_2O temp (C)	pH	Conductivity (µ mho)	DOC (mg L⁻¹)	Color (mg L⁻¹ PtCo)	Peak wavelength	Peak absorbance	Hg Conc.† (ng L⁻¹)	Li7 Conc. (µg L⁻¹)	Be9 Conc. (µg L⁻¹)	Mg26 Conc. (µg L⁻¹)	Al27 Conc. (µg L⁻¹)	Ti47 Conc. (µg L⁻¹)
Stream 10																	
LKC-153-STT-1R2	4/25/97	12:00			0.5	4.43		2.10	14.385	360	0.016	2.2	0.79	0.01	157.91	499.84	0.39
LKC-160-STT-1R1	6/18/97	20:00	0.834			4.38		3.70	27.447	351	0.029	3.7	0.84	0.04	115.81	372.66	0.48
LKC-160-STT-1R2	6/19/97	12:00	0.543		9.5	4.37		4.29	30.495	350.5	0.038	3.2	0.83	0.02	121.37	414.00	0.44
LKC-164-STT-1R1	7/3/97	18:35	0.026		13.5	4.42	24.2	3.29	19.174	349.5	0.035	2.7	1.05	0.02	109.75	340.41	0.41
LKC-164-STT-1R2	7/4/97	15:40	0.171		11.5	4.45	23.5	4.27	27.883	350.5	0.034	4.1	1.04	0.04	120.04	401.91	0.40
LKC-168-STT-1R1	7/9/97	11:35	1.328		2.5	4.37	26.9	5.77	43.993	344	0.05	5.2	0.88	0.01	121.73	457.16	0.97
LKC-181-STT-1R1	8/21/97	17:25	1.798		2.0	4.46	23.5	5.79	44.864	350.5	0.048	6.2	1.12	0.04	123.28	541.16	1.03
LKC-187-STT-1R1	9/20/97	12:40	0.276		3.0	4.43	23.4	4.17	21.787	350.5	0.03	4.6	1.12	0.05	111.37	399.78	0.45
LKC-187-STT-1R2	9/20/97	14:45	0.422			4.42	25.9	4.60	25.706	351	0.034	3.9	1.29	0.03	134.51	470.16	0.53
LKC-188-STT-1R1	9/23/97	13:00	0.215		0.0	4.49	24.2	4.03	24.399	350.5	0.027	3.4	1.18	0.03	124.28	435.01	0.45
LKC-188-STT-1R2	9/23/97	16:10	0.472			4.44	25.2	4.88	30.495	351	0.037	3.9	1.25	0.05	129.84	472.75	0.53
LKC-192-STT-1R1	11/1/97	16:30	1.053			4.47	29.6	5.21	35.72	350.5	0.04	4.1	1.10	0.03	166.01	503.26	0.70
LKC-192-STT-1R2	11/2/97	15:05	0.702			4.43	28.2	5.05	29.625	344	0.037	4.6	0.99	0.03	144.60	470.49	0.56
Stream 10 -- FILTERED																	
LKC -153-STT -1F2	4/25/97	12:00			0.5	4.43		2.10	14.385	360	0.016	1.5	0.83	0.03	166.14	517.19	0.27
LKC -160-STT -1F1	6/18/97	20:00	0.834			4.38		3.70	27.447	351	0.029	3.2	0.81	0.02	116.34	364.70	0.36
LKC -160-STT -1F2	6/19/97	12:00	0.543		9.5	4.37		4.29	30.495	350.5	0.038	3.2	0.80	0.02	127.07	427.40	0.50
LKC -164-STT -1F1	7/3/97	18:35	0.026		13.5	4.42	24.2	3.29	19.174	349.5	0.035	2.7	1.10	0.04	111.88	354.10	0.30
LKC -164-STT -1F2	7/4/97	15:40	0.171		11.5	4.45	23.5	4.27	27.883	350.5	0.034	4.1	1.03	0.04	114.83	390.01	0.42
LKC -168-STT -1F1	7/9/97	11:35	1.328		2.5	4.37	26.9	5.77	43.993	344	0.05	3.6	0.95	0.04	121.75	445.92	0.62
LKC -181-STT -1F1	8/21/97	17:25	1.798		2.0	4.46	23.5	5.79	44.864	350.5	0.048	3.0	1.13	0.04	124.73	506.43	0.59
LKC -187-STT -1F1	9/20/97	12:40	0.276		3.0	4.43	23.4	4.17	21.787	350.5	0.03	2.5	1.12	0.03	105.34	380.61	0.36
LKC -187-STT -1F2	9/20/97	14:45	0.422			4.42	25.9	4.60	25.706	351	0.034	3.9	1.34	0.02	136.31	459.43	0.52
LKC -188-STT -1F1	9/23/97	13:00	0.215		0.0	4.49	24.2	4.03	24.399	350.5	0.027	2.1	1.20	0.01	131.17	457.32	0.44
LKC -188-STT -1F2	9/23/97	16:10	0.472			4.44	25.2	4.88	30.495	351	0.037		1.24	0.02	131.63	485.40	0.60
LKC -192-STT -1F1	11/1/97	16:30	1.053			4.47	29.6	5.21	35.72	350.5	0.04	3.0	1.10	0.03	172.24	502.15	0.64
LKC -192-STT -1F2	11/2/97	15:05	0.702			4.43	28.2	5.05	29.625	344	0.037	3.1	1.03	0.04	152.11	479.62	0.53
Lamoille River at Jeffersonville																	
LKC-155-STJ-1R1	4/21/97	15:10										3.5	0.53	0.00	1269.14	151.04	5.31
LKC-169-STJ-1R1	7/10/97	10:00				6.91	100.4	5.61	50.089	348	0.1	7.4	0.74	0.03	2136.08		9.44
LKC-184-STJ-1R1	8/22/97	13:00				7.41	78.6	5.71	61.41	344	0.053	4.6	0.40	0.01	1412.95	92.80	2.82
LKC-193-STJ-1R1	11/3/97	12:30				7.06	75	3.99	37.898	350.5	0.037	4.1	0.52	0.00	1579.06	107.56	3.25
Lamoille River at Jeffersonville -- FILTERED																	
LKC -155-STJ -1F1	4/21/97	15:10										1.3	0.29	0.01	1230.94	26.02	0.71
LKC -169-STJ -1F1	7/10/97	10:00				6.91	100.4	5.61	50.089	348	0.1	3.7	0.45	0.00	2088.06	23.94	0.81
LKC -184-STJ -1F1	8/22/97	13:00				7.41	78.6	5.71	61.41	344	0.053	1.6	0.33	0.03	1412.20	26.82	0.75
LKC -193-STJ -1F1	11/3/97	12:30				7.06	75	3.99	37.898	350.5	0.037	1.8	0.42	0.01	1574.53	29.90	0.75

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Sample time	Stream flow (cfs)	Nettle flow (mm hr⁻¹)	H_2O temp (C)	pH	Conductivity (µ mho)	DOC (mg L⁻¹)	Color (mg L⁻¹ PtCo)	Peak wavelength	Peak absorbance	Hg Conc.† (ng L⁻¹)	Li7 Conc. (µg L⁻¹)	Be9 Conc. (µg L⁻¹)	Mg26 Conc. (µg L⁻¹)	Al27 Conc. (µg L⁻¹)	Ti47 Conc. (µg L⁻¹)
Mid Nettle Brook -- FILTERED																	
LKC -145-STN -MF1	4/12/97	17:28	0.102	0.094	1.2	5.42		1.68	10.902	360	0.01	0.9					
LKC -148-STN -MF1	4/20/97	12:30	0.151	0.140	5.1	5.54		1.99	16.997	350.5	0.019	1.1	0.36	0.04	185.61	58.36	0.43
LKC -148-STN -MF2	4/20/97	15:45	0.249	0.231	6.2	5.10		2.22	25.706	350.5	0.022	1.4	0.34	0.04	185.71	66.51	0.39
LKC -158-STN -MF1	6/18/97	18:45	0.068	0.063	12.3	5.54		4.08	45.299	349.5	0.051	2.0	0.41	0.02	184.57	92.93	0.89
LKC -162-STN -MF1	7/3/97	17:21	0.037	0.034	15.0	5.59	19.4	4.88	45.299	350.5	0.046	3.3	0.49	0.06	241.15	116.69	0.77
LKC -166-STN -MF1	7/9/97	9:45	0.242	0.224	13.5	5.65	15.7	5.99	61.846	340	0.059	3.0	0.42	0.04	199.94	129.56	0.65
LKC -166-STN -MF2	7/9/97	15:47	0.048	0.044	13.4	5.63	15	4.32	36.156	350.5	0.041	2.5	0.46	0.02	211.23	106.86	0.59
LKC -173-STN -MF1	7/15/97	17:58	0.343	0.318	16.3	5.43	12.2	4.23	45.299	360	0.038	2.7	0.50	0.05	197.85	115.68	0.67
LKC -176-STN -MF1	8/13/97	10:07	0.207	0.192	14.3	5.61	12.8	6.64	79.698	344	0.071	2.3	0.44	0.03	208.07	137.27	0.96
LKC -176-STN -MF2	8/13/97	15:35	0.091	0.084	14.2	5.63	11.9	4.92	45.735	350.5	0.048	2.6	0.46	0.04	176.22	112.97	0.64
LKC -179-STN -MF1	8/21/97	15:30	0.118	0.110	12.7	5.80	12.3	6.05	67.942	340	0.062	3.3	0.33	0.05	149.62	111.29	0.92
LKC -179-STN -MF2	8/22/97	10:20	0.033	0.030	12.9	5.26	12.5	3.34	28.318	350.5	0.031	2.0	0.43	0.02	175.03	84.04	0.52
LKC -190-STN -MF1	11/2/97	16:55	0.104	0.096	8.9	5.77	15.8	3.14	40.075	350.5	0.037	1.8	0.41	0.02	204.48	73.38	0.65
Upper Nettle Brook																	
LKC-146-STN-UR1	4/12/97	17:43	0.102	0.094	1.2	5.46		1.63	14.82	350.5	0.016	1.5	0.31	0.04	204.89	61.65	0.54
LKC-149-STN-UR1	4/20/97	12:45	0.168	0.156	5.4	5.42		2.13	26.577	360	0.02	2.1	0.33	0.03	187.53	71.27	1.16
LKC-149-STN-UR2	4/20/97	16:00	0.248	0.230	6.2	5.40		2.31	27.447	350.5	0.024	2.0	0.30	0.04	181.52	72.98	0.79
LKC-159-STN-UR1	6/18/97	19:00	0.068	0.063	12.3	5.70		5.94	69.683	344.5	0.069	3.5	0.38	0.04	216.73	123.81	1.40
LKC-163-STN-UR1	7/3/97	17:35	0.035	0.032	15.0	5.79	15.7	6.19	66.635	344.5	0.07	3.5	0.45	0.06	267.59	149.48	1.75
LKC-167-STN-UR1	7/9/97	10:04	0.204	0.189	13.5	5.35	16.2	6.18	62.716	347	0.114	3.7	0.43	0.06	202.41	158.43	1.27
LKC-167-STN-UR2	7/9/97	16:00	0.046	0.043	13.4	5.60	15.5	4.73	50.089	351	0.049	2.6	0.40	0.03	176.75	114.12	1.08
LKC-174-STN-UR1	7/15/97	18:13	0.343	0.318	16.3	5.50	13.9	5.72	72.296	350.5	0.07	5.5	0.46	0.06	194.38	159.49	1.56
LKC-177-STN-UR1	8/13/97	10:19	0.207	0.192	14.3	5.61	13.5	7.10	80.569	344.5	0.082	5.4	0.42	0.05	178.01	157.92	1.83
LKC-177-STN-UR2	8/13/97	15:53	0.086	0.079	14.3	5.60	13.3	5.16	54.008	340	0.048	3.3	0.42	0.06	179.29	134.76	1.14
LKC-180-STN-UR1	8/21/97	15:45	0.141	0.131	12.7	5.55	14.7	7.09	80.133	344.5	0.083	4.6	0.40	0.03	163.88	133.02	1.53
LKC-180-STN-UR2	8/22/97	10:30	0.033	0.030	12.9	5.70	14.5	4.20	45.735	351	0.046	5.1	0.40	0.04	174.63	100.04	1.22
LKC-191-STN-UR1	11/2/97	17:10	0.104	0.097	8.9	5.70	17.3	3.61	45.299	350.5	0.042	2.9	0.43	0.04	223.33	90.32	0.87
Upper Nettle Brook -- FILTERED																	
LKC -146-STN -UF1	4/12/97	17:43	0.102	0.094	1.2	5.46		1.63	14.82	350.5	0.016	1.0	0.30	0.03	222.08	64.05	0.50
LKC -149-STN -UF1	4/20/97	12:45	0.168	0.156	5.4	5.42		2.13	26.577	360	0.02	1.1	0.31	0.04	185.76	62.18	0.63
LKC -149-STN -UF2	4/20/97	16:00	0.248	0.230	6.2	5.40		2.31	27.447	350.5	0.024	1.3	0.32	0.02	187.49	69.80	0.53
LKC -159-STN -UF1	6/18/97	19:00	0.068	0.063	12.3	5.70		5.94	69.683	344.5	0.069	3.0	0.33	0.03	213.70	118.02	1.02
LKC -163-STN -UF1	7/3/97	17:35	0.035	0.032	15.0	5.79	15.7	6.19	66.635	344.5	0.07	3.0	0.42	0.07	267.29	137.99	1.27
LKC -167-STN -UF1	7/9/97	10:04	0.204	0.189	13.5	5.35	16.2	6.18	62.716	347	0.114	3.2	0.44	0.06	203.34	150.07	0.84
LKC -167-STN -UF2	7/9/97	16:00	0.046	0.043	13.4	5.60	15.5	4.73	50.089	351	0.049	2.1	0.41	0.06	178.21	100.29	0.83
LKC -174-STN -UF1	7/15/97	18:13	0.343	0.318	16.3	5.50	13.9	5.72	72.296	350.5	0.07	3.6	0.48	0.04	197.55	141.01	0.91
LKC -177-STN -UF1	8/13/97	10:19	0.207	0.192	14.3	5.61	13.5	7.10	80.569	344.5	0.082	3.4	0.43	0.03	182.83	137.07	0.96
LKC -177-STN -UF2	8/13/97	15:53	0.086	0.079	14.3	5.60	13.3	5.16	54.008	340	0.048	2.4	0.46	0.04	184.19	127.49	0.91
LKC -180-STN -UF1	8/21/97	15:45	0.141	0.131	12.7	5.55	14.7	7.09	80.133	344.5	0.083	3.0	0.40	0.03	169.05	129.20	1.11
LKC -180-STN -UF2	8/22/97	10:30	0.033	0.030	12.9	5.70	14.5	4.20	45.735	351	0.046	2.3	0.45	0.03	184.58	93.45	0.84
LKC -191-STN -UF1	11/2/97	17:10	0.104	0.097	8.9	5.70	17.3	3.61	45.299	350.5	0.042	2.1	0.40	0.03	209.67	81.85	0.66

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	V51 Conc. (μg L^{-1})	Cr53 Conc. (μg L^{-1})	Mn55 Conc. (μg L^{-1})	Co59 Conc. (μg L^{-1})	Ni60 Conc. (μg L^{-1})	Cμ65 Conc. (μg L^{-1})	Zn66 Conc. (μg L^{-1})	As75 Conc. (μg L^{-1})	Rb85 Conc. (μg L^{-1})	Sr88 Conc. (μg L^{-1})	Mo95 Conc. (μg L^{-1})	Ag107 Conc. (μg L^{-1})	Cd111 Conc. (μg L^{-1})	In115 Conc. (μg L^{-1})	Sb121 Conc. (μg L^{-1})	Ba137 Conc. (μg L^{-1})	La139 Conc. (μg L^{-1})	Ce140 Conc. (μg L^{-1})
Nettle Brook Weir																			
LKC-144-STN-WR1	4/12/97																		
LKC-147-STN-WR1	4/20/97	0.08	0.01	3.43	0.05	0.75	0.26	4.54	0.03	0.56	11.50	0	0	0.03	0	0	10.05	0.37	0.20
LKC-147-STN-WR2	4/20/97	0.14	0.08	7.85	0.08	0.85	0.36	4.98	0.05	0.64	11.43	0	0	0.04	0	0	10.77	0.66	0.40
LKC-157-STN-WR1	6/18/97	0.18	0.14	10.71	0.12	0.87	0.47	3.70	0.08	0.65	16.67	0.0122	0	0.03	0.0003	0	12.56	0.78	0.52
LKC-161-STN-WR1	7/3/97	0.16	0.08	7.26	0.09	1.00	0.51	3.92	0.10	0.78	18.90	0.0043	0.0013	0.04	0	0	13.27	0.69	0.36
LKC-165-STN-WR1	7/9/97	0.26	0.15	24.40	0.27	1.25	0.67	6.26	0.11	0.73	13.75	0.0082	0.0009	0.07	0.0009	0.0161	13.64	1.71	1.10
LKC-165-STN-WR2	7/9/97	0.11	0.09	4.98	0.08	0.90	0.44	3.94	0.10	0.57	14.80	0.009	0.0003	0.03	0	0.0055	12.20	0.69	0.34
LKC-172-STN-WR1	7/15/97	0.57	0.26	43.70	0.43	1.38	0.87	6.19	0.18	1.00	15.12	0.0156	0.0005	0.08	0.0025	0.0045	15.54	1.96	1.90
LKC-175-STN-WR1	8/13/97	0.26	0.09	18.80	0.19	1.18	0.67	4.60	0.12	0.80	14.97	0.0068	0.0013	0.05	0	0	11.69	1.42	0.88
LKC-175-STN-WR2	8/13/97	0.15	0.09	9.13	0.12	1.01	0.54	4.31	0.12	0.55	13.46	0.009	0	0.05	0.0002	0.0039	11.12	0.99	0.53
LKC-178-STN-WR1	8/21/97	0.34	0.14	23.93	0.24	1.05	0.66	4.14	0.13	0.74	13.44	0.0143	0.0022	0.04	0.0008	0	10.87	1.69	1.20
LKC-178-STN-WR2	8/22/97	0.10	0.10	5.07	0.07	0.78	0.39	3.01	0.08	0.49	15.50	0.0161	0	0.02	0	0	10.36	0.52	0.30
LKC-189-STN-WR1	11/2/97	0.08	0.03	6.17	0.05	0.80	0.38	4.56	0.07	1.24	12.36	0	0.0005	0.04	0	0	10.47	0.58	0.30
Nettle Brook Weir -- FILTERED																			
LKC -144-STN -WF1	4/12/97	0.04	0.00	2.27	0.02	0.75	0.21	5.39	0.05	0.53	11.68	0.0414	0.0014	0.03	0.0094	0.0422	9.93	0.25	0.10
LKC -147-STN -WF1	4/20/97	0.05	0.00	1.91	0.02	0.70	0.23	4.33	0.04	0.55	11.83	0	0.0019	0.03	0.003	0	10.06	0.28	0.13
LKC -147-STN -WF2	4/20/97	0.06	0.02	2.49	0.03	0.74	0.29	4.64	0.04	0.58	10.83	0	0	0.03	0.0003	0	9.83	0.42	0.20
LKC -157-STN -WF1	6/18/97	0.11	0.09	2.48	0.04	0.78	0.40	3.09	0.07	0.61	16.01	0.0226	0.0018	0.03	0.0068	0.0148	11.38	0.53	0.26
LKC -161-STN -WF1	7/3/97	0.13	0.07	3.81	0.05	0.99	0.50	3.88	0.09	0.78	19.54	0.01	0.00005	0.03	0	0	13.39	0.59	0.27
LKC -165-STN -WF1	7/9/97	0.11	0.09	4.14	0.06	1.10	0.53	5.29	0.11	0.67	13.41	0.0484	0.0007	0.05	0.0216	0.1203	12.37	1.03	0.43
LKC -165-STN -WF2	7/9/97	0.09	0.08	2.31	0.06	0.81	0.40	3.65	0.09	0.51	14.10	0.0111	0	0.03	0.0062	0.0093	11.07	0.56	0.24
LKC -172-STN -WF1	7/15/97	0.15	0.09	2.07	0.04	0.88	0.48	3.99	0.12	0.81	13.68	0.01945	0.001	0.03	0.00385	0.02295	11.58	0.68	0.41
LKC -175-STN -WF1	8/13/97	0.16	0.10	3.90	0.05	1.22	0.61	4.12	0.11	0.75	15.70	0.0064	0.0012	0.04	0	0	10.96	1.03	0.45
LKC -175-STN -WF2	8/13/97	0.12	0.09	3.23	0.06	0.95	0.50	3.91	0.10	0.53	13.09	0.0233	0.0012	0.03	0.0054	0.0311	10.47	0.77	0.34
LKC -178-STN -WF1	8/21/97	0.14	0.09	2.92	0.05	0.92	0.51	3.16	0.10	0.68	13.35	0.0282	0.0017	0.03	0.0057	0.0286	9.51	1.05	0.43
LKC -178-STN -WF2	8/22/97	0.10	0.07	3.86	0.05	0.78	0.42	2.96	0.08	0.48	15.82	0.01145	0	0.02	0.00035	0.0001	10.40	0.46	0.22
LKC -189-STN -WF1	11/2/97	0.07	0.03	5.49	0.05	0.80	0.38	4.49	0.06	1.22	12.37	0	0.001	0.03	0.0016	0	10.30	0.52	0.26
Mid Nettle Brook																			
LKC-145-STN-MR1	4/12/97	0.04	0.01	9.39	0.05	1.10	0.26	6.88	0.06	0.57	10.55	0.0011	0	0.06	0	0	11.36	0.49	0.19
LKC-148-STN-MR1	4/20/97	0.08	0.07	17.85	0.14	0.92	0.32	6.09	0.04	0.59	10.46	0	0	0.06	0	0	12.21	0.78	0.36
LKC-148-STN-MR2	4/20/97	0.08	0.04	14.03	0.11	0.94	0.32	5.86	0.04	0.54	10.00	0	0	0.05	0	0	11.36	0.86	0.35
LKC-158-STN-MR1	6/18/97	0.10	0.10	15.03	0.13	1.07	0.49	5.29	0.09	0.55	10.46	0.0013	0	0.05	0	0	12.11	1.38	0.58
LKC-162-STN-MR1	7/3/97	0.11	0.09	9.31	0.09	1.46	0.64	7.68	0.11	0.81	14.13	0.0104	0	0.06	0.0008	0.0164	16.34	1.45	0.54
LKC-166-STN-MR1	7/9/97	0.12	0.15	23.81	0.16	1.28	0.55	6.76	0.11	0.62	12.17	0.0068	0.0001	0.07	0	0	14.19	1.60	0.61
LKC-166-STN-MR2	7/9/97	0.10	0.10	7.14	0.07	1.17	0.52	6.00	0.10	0.42	11.94	0.0054	0	0.05	0.0001	0.0184	12.99	1.13	0.41
LKC-173-STN-MR1	7/15/97	0.20	0.18	39.07	0.30	1.35	0.62	6.88	0.10	0.73	11.62	0.0078	0.0017	0.09	0.0001	0.0094	14.17	1.91	0.84
LKC-176-STN-MR1	8/13/97	0.16	0.10	17.91	0.14	1.60	0.73	7.34	0.15	0.71	12.57	0	0	0.08	0	0	14.04	2.31	0.83
LKC-176-STN-MR2	8/13/97	0.11	0.10	10.68	0.10	1.22	0.53	5.84	0.10	0.41	10.86	0.0107	0.0008	0.06	0.0012	0.0044	12.27	1.39	0.54
LKC-179-STN-MR1	8/21/97	0.13	0.09	9.81	0.11	1.20	0.60	5.22	0.12	0.61	9.56	0.0068	0	0.06	0.0007	0.0082	10.96	2.07	0.75
LKC-179-STN-MR2	8/22/97	0.07	0.12	4.35	0.06	0.97	0.42	4.66	0.08	0.25	9.96	0.0101	0.0003	0.04	0.0001	0	10.64	0.92	0.35
LKC-190-STN-MR1	11/2/97	0.06	0.03	11.49	0.06	0.97	0.38	5.74	0.07	1.18	10.80	0	0	0.05	0	0	11.42	0.90	0.32

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Sample time	Stream flow (cfs)	Nettle flow (mm hr^{-1})	H$_2$O temp (C)	pH	Conductivity (μ mho)	DOC (mg L^{-1})	Color (mg L^{-1} PtCo)	Peak wavelength	Peak absorbance	Hg Conc.† (ng L^{-1})	Li7 Conc. (μg L^{-1})	Be9 Conc. (μg L^{-1})	Mg26 Conc. (μg L^{-1})	Al27 Conc. (μg L^{-1})	Ti47 Conc. (μg L^{-1})
Browns River at Fairfax																	
LKC-154-STB-1R1	4/21/97	15:40										0.9					
LKC-170-STB-1R1	7/10/97	9:40				7.02	74.5	5.32	45.735	453	0.011	5.4	0.24	0.03	1483.29	24.91	0.72
LKC-183-STB-1R1	8/22/97	12:34				7.50	142	3.14	25.706	360	0.018	2.4	0.38	0.00	3104.15	134.69	7.23
LKC-194-STB-1R1	11/3/97	12:55				7.07	63.3	4.86	56.621	350.5	0.046	13.7	0.42	0.04	1219.50	349.78	15.56
Browns River at Fairfax -- FILTERED																	
LKC -154-STB -FLT	4/21/97	15:40										0.9					
LKC -170-STB -1F1	7/10/97	9:40				7.02	74.5	5.32	45.735	453	0.011	1.8	0.42	0.05	1536.95	239.19	9.22
LKC -183-STB -1F1	8/22/97	12:34				7.50	142	3.14	25.706	360	0.018	0.9	0.23	0.00	3120.50	11.40	0.65
LKC -194-STB -1F1	11/3/97	12:55				7.07	63.3	4.86	56.621	350.5	0.046	5.1	0.21	0.00	1245.76	28.60	0.86
Lamoille River at Milton																	
LKC-156-STM-1R1	4/21/97	16:15										3.0	0.46	0.03	1532.30	193.99	5.77
LKC-171-STM-1R1	7/10/97	9:05				7.21	136.1	4.71	34.849	351	0.034	2.7	0.64	0.02	2925.45	176.06	6.51
LKC-182-STM-1R1	8/22/97	12:08				7.41	107.9	5.40	44.864	350.5	0.04	2.6	0.44	0.00	2167.00	34.88	1.47
LKC-195-STM-1R1	11/3/97	13:25				7.26	108.8	3.37	26.141	350.5	0.026	3.4	0.40	0.00	2325.72	68.17	3.16
Lamoille River at Milton -- FILTERED																	
LKC -156-STM -1F1	4/21/97	16:15										1.7	0.28	0.03	1498.54	26.33	0.72
LKC -171-STM -1F1	7/10/97	9:05				7.21	136.1	4.71	34.849	351	0.034	1.5	0.49	0.01	2839.31	17.98	0.66
LKC -182-STM -1F1	8/22/97	12:08				7.41	107.9	5.40	44.864	350.5	0.04	1.1	0.41	0.00	2120.05	14.51	0.60
LKC -195-STM -1F1	11/3/97	13:25				7.26	108.8	3.37	26.141	350.5	0.026	1.0	0.36	0.00	2359.65	12.87	0.76

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	V51 Conc. (µg L^{-1})	Cr53 Conc. (µg L^{-1})	Mn55 Conc. (µg L^{-1})	Co59 Conc. (µg L^{-1})	Ni60 Conc. (µg L^{-1})	Cµ65 Conc. (µg L^{-1})	Zn66 Conc. (µg L^{-1})	As75 Conc. (µg L^{-1})	Rb85 Conc. (µg L^{-1})	Sr88 Conc. (µg L^{-1})	Mo95 Conc. (µg L^{-1})	Ag107 Conc. (µg L^{-1})	Cd111 Conc. (µg L^{-1})	In115 Conc. (µg L^{-1})	Sb121 Conc. (µg L^{-1})	Ba137 Conc. (µg L^{-1})	La139 Conc. (µg L^{-1})	Ce140 Conc. (µg L^{-1})
[illegible] Brook Weir																			
LKC-153-STT-1R2	4/25/97	0.04	0.18	46.45	0.95	1.15	2.20	15.04	0.12	0.30	2.41	0	0	0.14	0	0	3.73	1.80	2.60
LKC-160-STT-1R1	6/18/97	0.06	0.29	27.50	0.62	0.94	2.66	11.61	0.17	0.16	2.07	0.0018	0	0.13	0.0006	0.0316	3.42	2.23	3.23
LKC-160-STT-1R2	6/19/97	0.10	0.24	27.47	0.61	1.00	2.83	12.56	0.21	0.12	2.07	0	0	0.14	0	0.045	3.58	2.37	3.55
LKC-164-STT-1R1	7/3/97	0.04	0.27	25.51	0.71	1.09	2.73	10.59	0.15	0.10	2.13	0	0	0.12	0	0.0357	3.39	2.04	3.12
LKC-164-STT-1R2	7/4/97	0.07	0.34	25.80	0.70	1.04	2.98	11.70	0.21	0.09	2.12	0	0	0.12	0	0.0441	3.55	2.39	3.57
LKC-168-STT-1R1	7/9/97	0.18	0.28	29.54	0.63	1.04	3.11	13.42	0.25	0.10	2.18	0.009	0	0.15	0.0007	0.0718	3.69	2.65	4.13
LKC-181-STT-1R1	8/21/97	0.16	0.38	28.90	0.75	1.13	3.43	12.56	0.27	0.14	2.19	0.0043	0	0.16	0.001	0.0707	3.41	2.88	4.32
LKC-187-STT-1R1	9/20/97	0.05	0.32	30.05	0.81	1.06	2.83	10.95	0.17	0.19	2.09	0.0029	0	0.15	0.0003	0.05	3.48	2.25	3.36
LKC-187-STT-1R2	9/20/97	0.08	0.33	34.49	0.86	1.23	3.15	12.67	0.20	0.15	2.33	0	0	0.14	0	0.0107	3.58	2.51	3.66
LKC-188-STT-1R1	9/23/97	0.06	0.29	31.34	0.83	1.14	2.90	12.39	0.21	0.11	2.13	0	0	0.14	0	0	3.27	2.23	3.35
LKC-188-STT-1R2	9/23/97	0.09	0.32	30.70	0.80	1.15	3.15	13.06	0.21	0.09	2.15	0	0.0001	0.15	0	0.0093	3.27	2.52	3.70
LKC-192-STT-1R1	11/1/97	0.11	0.31	54.63	0.79	1.14	2.79	15.69	0.24	0.35	2.21	0.0054	0	0.18	0	0.0061	3.34	2.43	3.57
LKC-192-STT-1R2	11/2/97	0.11	0.27	43.07	0.76	1.09	2.85	14.96	0.20	0.18	2.19	0	0.0001	0.16	0.0004	0	3.46	2.31	3.46
Stream 10 -- FILTERED																			
LKC -153-STT -1F2	4/25/97	0.05	0.21	48.10	0.98	1.15	2.21	15.42	0.14	0.29	2.50	0.0014	0	0.14	0.0017	0	3.88	1.84	2.73
LKC -160-STT -1F1	6/18/97	0.06	0.23	27.50	0.61	0.94	2.51	11.45	0.16	0.15	2.01	0	0	0.13	0.0028	0.0291	3.41	2.07	3.11
LKC -160-STT -1F2	6/19/97	0.11	0.30	28.30	0.62	1.05	2.83	13.00	0.19	0.12	2.14	0.0043	0	0.16	0.0012	0.0452	3.57	2.35	3.55
LKC -164-STT -1F1	7/3/97	0.05	0.25	26.61	0.71	1.12	2.80	11.21	0.17	0.10	2.20	0.0032	0	0.12	0.0006	0.0337	3.50	2.04	3.18
LKC -164-STT -1F2	7/4/97	0.08	0.31	25.18	0.68	1.06	2.89	11.47	0.19	0.09	2.11	0.00415	0	0.14	0.0025	0.05165	3.54	2.36	3.53
LKC -168-STT -1F1	7/9/97	0.18	0.27	29.71	0.65	1.07	3.00	13.64	0.24	0.08	2.15	0.0369	0.0011	0.17	0.0097	0.1276	3.79	2.52	3.88
LKC -181-STT -1F1	8/21/97	0.13	0.39	28.49	0.72	1.11	3.13	12.42	0.26	0.13	2.16	0.0136	0	0.15	0.0022	0.081	3.30	2.61	3.95
LKC -187-STT -1F1	9/20/97	0.05	0.33	28.95	0.81	1.07	2.75	11.07	0.18	0.17	2.01	0.0108	0	0.13	0.0014	0.0701	3.36	2.15	3.20
LKC -187-STT -1F2	9/20/97	0.08	0.30	34.61	0.84	1.19	3.14	12.86	0.20	0.14	2.31	0	0	0.16	0	0.0119	3.58	2.44	3.57
LKC -188-STT -1F1	9/23/97	0.06	0.27	32.64	0.83	1.13	2.82	12.53	0.18	0.11	2.19	0.0025	0.0001	0.14	0.0048	0.0026	3.24	2.20	3.28
LKC -188-STT -1F2	9/23/97	0.09	0.36	31.96	0.82	1.16	3.14	13.45	0.21	0.09	2.24	0	0.0008	0.15	0.0028	0.0175	3.26	2.51	3.72
LKC -192-STT -1F1	11/1/97	0.11	0.29	55.32	0.79	1.13	2.65	15.87	0.22	0.35	2.25	0.0357	0.0016	0.17	0.0112	0.0578	3.39	2.35	3.52
LKC -192-STT -1F2	11/2/97	0.11	0.27	44.05	0.77	1.15	2.85	18.63	0.24	0.18	2.22	0.00715	0.00055	0.17	0.00255	0.0244	3.51	2.36	3.49
Lamoille River at Jeffersonville																			
LKC-155-STJ-1R1	4/21/97	0.40	0.51	25.43	0.31	2.13	0.92	2.07	0.53	0.91	41.34	0.0257	0	0.02	0	0	5.06	0.59	0.99
LKC-169-STJ-1R1	7/10/97	0.91	1.02	135.55	0.85	3.84	1.84	3.57	1.44	1.74	71.78	0.0675	0.0027	0.02	0.0012	0.0205	9.15	1.35	2.70
LKC-184-STJ-1R1	8/22/97	0.29	0.38	34.36	0.25	1.98	1.11	1.40	0.74	1.04	54.08	0.0904	0.0005	0.02	0.0001	0.0178	5.48	0.69	0.98
LKC-193-STJ-1R1	11/3/97	0.29	0.36	53.39	0.31	2.07	1.15	37.78	0.64	1.17	50.71	0.06	0.0001	0.03	0	0	5.96	0.76	1.10
Lamoille River at Jeffersonville -- FILTERED																			
LKC -155-STJ -1F1	4/21/97	0.11	0.23	1.24	0.04	1.27	0.58	0.49	0.29	0.73	41.01	0.04105	0.0001	0.00	0.00045	0	3.75	0.18	0.18
LKC -169-STJ -1F1	7/10/97	0.18	0.34	1.42	0.06	1.87	0.94	0.24	0.73	1.47	72.17	0.1578	0.0003	0.00	0.0026	0.0419	5.10	0.16	0.20
LKC -184-STJ -1F1	8/22/97	0.16	0.26	1.55	0.06	1.64	0.92	0.50	0.57	0.98	54.24	0.1062	0	0.01	0	0.0262	4.49	0.29	0.24
LKC -193-STJ -1F1	11/3/97	0.13	0.22	3.26	0.06	1.55	0.88	105.54	0.36	1.05	50.28	0.0846	0.0011	0.02	0.0007	0	4.68	0.25	0.21

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	V51 Conc. (µg L^{-1})	Cr53 Conc. (µg L^{-1})	Mn55 Conc. (µg L^{-1})	Co59 Conc. (µg L^{-1})	Ni60 Conc. (µg L^{-1})	Cµ65 Conc. (µg L^{-1})	Zn66 Conc. (µg L^{-1})	As75 Conc. (µg L^{-1})	Rb85 Conc. (µg L^{-1})	Sr88 Conc. (µg L^{-1})	Mo95 Conc. (µg L^{-1})	Ag107 Conc. (µg L^{-1})	Cd111 Conc. (µg L^{-1})	In115 Conc. (µg L^{-1})	Sb121 Conc. (µg L^{-1})	Ba137 Conc. (µg L^{-1})	La139 Conc. (µg L^{-1})	Ce140 Conc. (µg L^{-1})
[illegible] -- FILTERED																			
LKC -145-STN -MF1	4/12/97																		
LKC -148-STN -MF1	4/20/97	0.05	0.07	7.70	0.05	0.96	0.29	5.58	0.05	0.55	9.94	0	0	0.05	0.0019	0	11.29	0.54	0.19
LKC -148-STN -MF2	4/20/97	0.05	0.00	8.57	0.06	0.95	0.29	5.66	0.05	0.52	9.67	0	0	0.05	0.0001	0	11.15	0.67	0.24
LKC -158-STN -MF1	6/18/97	0.07	0.08	4.36	0.05	1.07	0.44	5.03	0.08	0.54	10.36	0.0013	0	0.04	0	0	11.55	1.16	0.39
LKC -162-STN -MF1	7/3/97	0.09	0.09	7.18	0.07	1.43	0.60	7.28	0.10	0.78	13.81	0.0167	0	0.07	0.00315	0.0351	15.81	1.32	0.45
LKC -166-STN -MF1	7/9/97	0.11	0.10	18.20	0.11	1.25	0.52	6.77	0.11	0.59	12.05	0.0068	0.0004	0.07	0.0002	0.0057	13.84	1.42	0.50
LKC -166-STN -MF2	7/9/97	0.08	0.11	5.56	0.06	1.20	0.50	6.12	0.09	0.42	11.96	0.0197	0	0.05	0.0033	0.0316	12.75	1.05	0.36
LKC -173-STN -MF1	7/15/97	0.12	0.14	11.29	0.07	1.22	0.48	5.89	0.12	0.62	11.70	0.0224	0.0015	0.05	0.0024	0.0262	13.37	1.29	0.46
LKC -176-STN -MF1	8/13/97	0.12	0.05	12.15	0.09	1.47	0.64	6.82	0.13	0.69	11.99	0	0	0.07	0	0	13.11	1.95	0.67
LKC -176-STN -MF2	8/13/97	0.10	0.11	8.02	0.07	1.21	0.58	6.05	0.10	0.40	10.95	0.0659	0.0042	0.06	0.0213	0.1439	12.20	1.31	0.49
LKC -179-STN -MF1	8/21/97	0.10	0.08	6.18	0.08	1.14	0.55	5.07	0.11	0.59	9.30	0.01165	0	0.05	0.0017	0.0155	10.46	1.82	0.61
LKC -179-STN -MF2	8/22/97	0.07	0.11	3.17	0.05	1.02	0.45	5.01	0.08	0.24	10.26	0.012	0	0.04	0.0047	0.0102	10.78	0.88	0.31
LKC -190-STN -MF1	11/2/97	0.05	0.06	9.40	0.05	0.88	0.36	5.29	0.06	1.10	9.99	0	0	0.04	0.0004	0	10.48	0.76	0.26
Upper Nettle Brook																			
LKC-146-STN-UR1	4/12/97	0.05	0.02	15.23	0.12	0.91	0.26	6.27	0.04	0.55	10.16	0	0	0.06	0	0	11.13	0.51	0.19
LKC-149-STN-UR1	4/20/97	0.07	0.07	15.80	0.15	0.93	0.31	5.66	0.05	0.53	10.07	0	0	0.04	0	0	11.68	0.80	0.29
LKC-149-STN-UR2	4/20/97	0.06	0.04	14.17	0.13	0.89	0.31	5.63	0.05	0.51	9.56	0	0	0.04	0	0	10.95	0.82	0.29
LKC-159-STN-UR1	6/18/97	0.13	0.12	59.90	0.36	1.30	0.53	5.98	0.13	0.64	12.55	0.012	0.0009	0.06	0	0	13.85	1.88	0.69
LKC-163-STN-UR1	7/3/97	0.17	0.14	106.39	0.58	1.60	0.69	7.15	0.15	0.72	16.15	0.023	0	0.07	0.0011	0.0332	16.15	2.07	0.73
LKC-167-STN-UR1	7/9/97	0.13	0.16	64.38	0.43	1.45	0.56	6.88	0.13	0.46	13.12	0.005	0	0.07	0.0008	0.0225	15.17	1.73	0.68
LKC-167-STN-UR2	7/9/97	0.12	0.10	58.39	0.40	1.24	0.49	5.68	0.12	0.32	11.95	0.0082	0	0.07	0	0.007	13.71	1.42	0.54
LKC-174-STN-UR1	7/15/97	0.17	0.14	65.94	0.47	1.48	0.58	6.14	0.14	0.58	12.50	0.0192	0.0011	0.08	0.0008	0.0076	14.94	2.17	0.74
LKC-177-STN-UR1	8/13/97	0.19	0.13	61.88	0.53	1.40	0.68	6.26	0.14	0.66	12.74	0.0108	0	0.08	0	0.0105	14.86	2.36	0.88
LKC-177-STN-UR2	8/13/97	0.13	0.11	52.79	0.40	1.27	0.54	5.34	0.12	0.35	12.10	0.0122	0	0.07	0	0.0095	13.02	1.49	0.57
LKC-180-STN-UR1	8/21/97	0.15	0.09	45.75	0.38	1.27	0.60	4.82	0.15	0.61	11.29	0.0086	0	0.06	0	0.0046	12.15	2.07	0.76
LKC-180-STN-UR2	8/22/97	0.11	0.15	52.66	0.36	1.08	0.39	4.21	0.11	0.30	11.68	0.0101	0.0008	0.04	0.0003	0	11.74	1.30	0.48
LKC-191-STN-UR1	11/2/97	0.07	0.05	29.90	0.22	1.10	0.34	6.20	0.07	1.25	11.97	0	0.0001	0.04	0	0	12.88	1.06	0.35
Upper Nettle Brook -- FILTERED																			
LKC -146-STN -UF1	4/12/97	0.04	0.00	16.02	0.12	0.93	0.22	6.33	0.05	0.55	10.73	0.0154	0	0.05	0.0022	0	11.11	0.48	0.18
LKC -149-STN -UF1	4/20/97	0.06	0.04	13.98	0.13	0.91	0.29	5.62	0.05	0.55	10.10	0	0	0.05	0	0	11.42	0.66	0.23
LKC -149-STN -UF2	4/20/97	0.05	0.04	13.74	0.12	0.93	0.30	5.64	0.05	0.51	9.78	0	0	0.04	0	0	10.99	0.76	0.27
LKC -159-STN -UF1	6/18/97	0.12	0.11	56.31	0.32	1.38	0.52	5.95	0.13	0.62	12.49	0.01445	0.00015	0.06	0.00065	0.00275	13.71	1.78	0.62
LKC -163-STN -UF1	7/3/97	0.15	0.14	97.67	0.48	1.51	0.64	6.81	0.17	0.71	15.83	0.0319	0.0002	0.06	0.0035	0.0403	15.39	1.82	0.64
LKC -167-STN -UF1	7/9/97	0.12	0.09	64.27	0.42	1.47	0.55	6.84	0.12	0.44	13.11	0.0068	0	0.06	0.0027	0.0311	14.93	1.55	0.60
LKC -167-STN -UF2	7/9/97	0.11	0.10	55.92	0.36	1.21	0.46	5.86	0.14	0.33	12.07	0.0104	0	0.06	0.0025	0.0157	13.77	1.32	0.50
LKC -174-STN -UF1	7/15/97	0.14	0.12	62.08	0.39	1.38	0.56	6.29	0.15	0.57	12.49	0.0149	0	0.06	0.0022	0.0204	14.59	1.88	0.65
LKC -177-STN -UF1	8/13/97	0.12	0.10	46.45	0.33	1.34	0.61	5.61	0.14	0.62	12.08	0.0082	0	0.08	0	0.0143	13.53	1.82	0.65
LKC -177-STN -UF2	8/13/97	0.12	0.16	50.83	0.36	1.30	0.54	5.58	0.11	0.35	12.34	0.0104	0	0.05	0.0004	0.0118	13.14	1.37	0.52
LKC -180-STN -UF1	8/21/97	0.12	0.14	44.43	0.34	1.25	0.62	5.01	0.13	0.61	11.76	0.0086	0	0.05	0.0007	0.0095	12.47	1.98	0.70
LKC -180-STN -UF2	8/22/97	0.09	0.14	51.88	0.33	1.10	0.41	5.04	0.10	0.30	11.79	0.0305	0	0.04	0.0047	0.0184	11.87	1.21	0.44
LKC -191-STN -UF1	11/2/97	0.07	0.04	27.90	0.21	1.01	0.43	7.13	0.07	1.18	11.24	0	0	0.05	0	0	11.84	0.92	0.30

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Nd146 Conc. (μg L⁻¹)	Sm147 Conc. (μg L⁻¹)	W182 Conc. (μg L⁻¹)	Tl205 Conc. (μg L⁻¹)	Pb208 Conc. (μg L⁻¹)	Cl (mg L⁻¹)	NO_3–N (mg L⁻¹)	NH_4–N (mg L⁻¹)	Ca (mg L⁻¹)	K (mg L⁻¹)	Mg (mg L⁻¹)	Na (mg L⁻¹)	SO_4–S (mg L⁻¹)	Si (mg L⁻¹)
Nettle Brook Weir															
LKC-144-STN-WR1	4/12/97						0.41	0.176	0.02	2.09	0.4	0.25	0.54	1.70	0.96
LKC-147-STN-WR1	4/20/97	0.40	0.08	0	0.001	0.08	0.25	0.148	0.011	1.94	0.36	0.22	0.49	1.49	0.81
LKC-147-STN-WR2	4/20/97	0.67	0.14	0	0.001	0.17	0.39	0.109	0.008	1.83	0.38	0.19	0.49	1.54	0.74
LKC-157-STN-WR1	6/18/97	0.74	0.15	0	0.002	0.23	0.28	0.08	0.017	3.01	0.41	0.33	0.64	1.57	1.24
LKC-161-STN-WR1	7/3/97	0.67	0.13	0	0.004	0.11	0.32	0.001	0.011	3.29	0.44	0.38	0.55	1.65	1.41
LKC-165-STN-WR1	7/9/97	1.71	0.31	0.0011	0.006	0.47	0.21	0.001	0.005	2.33	1.45	0.22	0.78	1.25	0.65
LKC-165-STN-WR2	7/9/97	0.72	0.15	0	0.004	0.08	0.21	0.001	0.053	2.48	0.4	0.25	0.42	1.60	0.97
LKC-172-STN-WR1	7/15/97	1.90	0.37	0.0019	0.004	1.09	0.18	0.001	0.005	2.35	0.5	0.29	0.33	1.22	0.69
LKC-175-STN-WR1	8/13/97	1.33	0.27	0	0.002	0.37	0.18	0.001	0.008	2.47	0.5	0.31	0.39	1.15	1.01
LKC-175-STN-WR2	8/13/97	1.02	0.21	0	0.004	0.16	0.18	0.001	0.005	2.33	0.45	0.29	0.35	1.28	0.88
LKC-178-STN-WR1	8/21/97	1.59	0.30	0.0024	0.004	0.50	0.14	0.001	0.001	2.32	0.49	0.29	0.37	1.06	1.02
LKC-178-STN-WR2	8/22/97	0.56	0.11	0	0.003	0.05	0.18	0.001	0.008	2.72	0.43	0.35	0.42	1.38	1.22
LKC-189-STN-WR1	11/2/97	0.59	0.11	0	0.002	0.06	0.36	0.001	0.001	2.19	0.98	0.33	0.72	1.67	0.65
Nettle Brook Weir -- FILTERED															
LKC -144-STN -WF1	4/12/97	0.28	0.06	0.0725	0.004	0.01	0.41	0.176	0.02	2.09	0.4	0.25	0.54	1.70	0.96
LKC -147-STN -WF1	4/20/97	0.32	0.07	0	0.001	0.02	0.25	0.148	0.011	1.94	0.36	0.22	0.49	1.49	0.81
LKC -147-STN -WF2	4/20/97	0.47	0.09	0	0.001	0.03	0.39	0.109	0.008	1.83	0.38	0.19	0.49	1.54	0.74
LKC -157-STN -WF1	6/18/97	0.51	0.11	0.0026	0.006	0.05	0.28	0.08	0.017	3.01	0.41	0.33	0.64	1.57	1.24
LKC -161-STN -WF1	7/3/97	0.62	0.12	0	0.003	0.05	0.32	0.001	0.011	3.29	0.44	0.38	0.55	1.65	1.41
LKC -165-STN -WF1	7/9/97	1.04	0.19	0.0878	0.008	0.06	0.21	0.001	0.005	2.33	1.45	0.22	0.78	1.25	0.65
LKC -165-STN -WF2	7/9/97	0.59	0.12	0.0028	0.006	0.03	0.21	0.001	0.053	2.48	0.4	0.25	0.42	1.60	0.97
LKC -172-STN -WF1	7/15/97	0.67	0.13	0.01585	0.003	0.07	0.18	0.001	0.005	2.35	0.5	0.29	0.33	1.22	0.69
LKC -175-STN -WF1	8/13/97	1.01	0.19	0	0.002	0.08	0.18	0.001	0.008	2.47	0.5	0.31	0.39	1.15	1.01
LKC -175-STN -WF2	8/13/97	0.83	0.15	0.0237	0.004	0.05	0.18	0.001	0.005	2.33	0.45	0.29	0.35	1.28	0.88
LKC -178-STN -WF1	8/21/97	0.99	0.18	0.0331	0.003	0.07	0.14	0.001	0.001	2.32	0.49	0.29	0.37	1.06	1.02
LKC -178-STN -WF2	8/22/97	0.49	0.10	0	0.003	0.03	0.18	0.001	0.008	2.72	0.43	0.35	0.42	1.38	1.22
LKC -189-STN -WF1	11/2/97	0.56	0.12	0	0.003	0.04	0.36	0.001	0.001	2.19	0.98	0.33	0.72	1.67	0.65
Mid Nettle Brook															
LKC-145-STN-MR1	4/12/97	0.51	0.10	0	0.001	0.05	0.46	0.268	0.008	1.64	0.38	0.19	0.47	1.72	0.7
LKC-148-STN-MR1	4/20/97	0.75	0.14	0	0.002	0.15	0.28	0.389	0.014	1.57	0.37	0.15	0.47	1.57	0.62
LKC-148-STN-MR2	4/20/97	0.81	0.16	0	0.001	0.12	0.32	0.152	0.012	1.52	0.37	0.14	0.48	1.38	0.6
LKC-158-STN-MR1	6/18/97	1.35	0.26	0	0.002	0.18	0.18	0.08	0.001	1.7	0.39	0.15	0.55	1.31	0.59
LKC-162-STN-MR1	7/3/97	1.45	0.27	0.0046	0.005	0.12	0.25	0.069	0.015	2.09	0.44	0.19	0.4	1.28	0.92
LKC-166-STN-MR1	7/9/97	1.51	0.29	0	0.004	0.16	0.18	0.069	0.024	2.03	0.46	0.23	0.35	1.25	0.54
LKC-166-STN-MR2	7/9/97	1.11	0.23	0.0052	0.004	0.08	0.18	0.001	0.016	1.85	0.41	0.22	0.39	1.31	0.65
LKC-173-STN-MR1	7/15/97	1.78	0.35	0	0.006	0.43	0.25	0.065	0.012	1.69	0.46	0.19	0.3	1.25	0.54
LKC-176-STN-MR1	8/13/97	2.04	0.38	0	0.005	0.21	0.18	0.001	0.001	1.72	0.47	0.2	0.29	1.12	0.74
LKC-176-STN-MR2	8/13/97	1.40	0.26	0.0079	0.003	0.12	0.18	0.001	0.001	1.7	0.42	0.19	0.28	1.22	0.69
LKC-179-STN-MR1	8/21/97	1.89	0.35	0	0.005	0.20	0.18	0.001	0.001	1.47	0.47	0.17	0.29	0.99	0.79
LKC-179-STN-MR2	8/22/97	0.98	0.19	0	0.002	0.07	0.35	0.001	0.001	1.5	0.41	0.17	0.32	1.22	0.78
LKC-190-STN-MR1	11/2/97	0.89	0.16	0	0.002	0.06	0.33	0.001	0.001	1.73	0.65	0.26	0.48	1.60	0.51

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	V51 Conc. (μg L⁻¹)	Cr53 Conc. (μg L⁻¹)	Mn55 Conc. (μg L⁻¹)	Co59 Conc. (μg L⁻¹)	Ni60 Conc. (μg L⁻¹)	Cu65 Conc. (μg L⁻¹)	Zn66 Conc. (μg L⁻¹)	As75 Conc. (μg L⁻¹)	Rb85 Conc. (μg L⁻¹)	Sr88 Conc. (μg L⁻¹)	Mo95 Conc. (μg L⁻¹)	Ag107 Conc. (μg L⁻¹)	Cd111 Conc. (μg L⁻¹)	In115 Conc. (μg L⁻¹)	Sb121 Conc. (μg L⁻¹)	Ba137 Conc. (μg L⁻¹)	La139 Conc. (μg L⁻¹)	Ce140 Conc. (μg L⁻¹)
Browns River at Fairfax																			
LKC-154-STB-1R1	4/21/97																		
LKC-170-STB-1R1	7/10/97	0.19	0.21	1.09	0.06	0.72	0.96	0.45	0.24	0.65	40.42	0.0918	0	0.01	0	0.0348	5.74	0.27	0.28
LKC-183-STB-1R1	8/22/97	0.49	0.45	99.84	0.33	1.19	0.94	1.69	0.31	1.01	77.42	0.0857	0.0022	0.01	0	0	10.57	0.70	1.30
LKC-194-STB-1R1	11/3/97	0.92	0.47	217.43	0.96	1.31	2.18	6.10	0.43	0.95	31.65	0.0243	0.0027	0.06	0	0	12.40	3.09	5.03
Browns River at Fairfax -- FILTERED																			
LKC -154-STB -FLT	4/21/97																		
LKC -170-STB -1F1	7/10/97	0.70	0.44	84.24	0.44	1.17	1.53	2.94	0.39	0.87	41.37	0.0703	0.0009	0.02	0.0025	0.0437	9.18	1.42	2.29
LKC -183-STB -1F1	8/22/97	0.19	0.22	0.52	0.06	0.90	0.57	0.20	0.22	0.90	77.80	0.13465	0.00065	0.00	0.00305	0.01185	7.81	0.07	0.08
LKC -194-STB -1F1	11/3/97	0.13	0.13	1.24	0.05	0.64	0.90	0.34	0.16	0.72	31.92	0.0518	0	0.00	0	0	5.20	0.34	0.32
Lamoille River at Milton																			
LKC-156-STM-1R1	4/21/97	0.43	0.58	28.56	0.28	1.81	0.95	1.81	0.46	1.00	43.08	0.0519	0.0013	0.01	0	0	6.16	0.59	1.03
LKC-171-STM-1R1	7/10/97	0.53	0.69	69.13	0.27	2.21	1.32	1.17	1.33	2.01	87.03	0.1967	0.0017	0.00	0.0002	0.0299	8.58	0.47	0.95
LKC-182-STM-1R1	8/22/97	0.25	0.30	21.53	0.09	1.62	1.02	0.35	1.00	1.42	70.99	0.1844	0	0.00	0.0003	0.0225	5.79	0.19	0.27
LKC-195-STM-1R1	11/3/97	0.25	0.38	52.57	0.20	1.59	0.77	1.07	0.62	1.16	66.52	0.0879	0.0006	0.01	0	0	6.49	0.35	0.62
Lamoille River at Milton -- FILTERED																			
LKC -156-STM -1F1	4/21/97	0.13	0.29	3.27	0.05	1.21	0.63	0.62	0.35	0.79	43.51	0.0549	0	0.01	0.0009	0.0018	4.49	0.17	0.19
LKC -171-STM -1F1	7/10/97	0.20	0.33	0.90	0.07	1.58	1.11	0.23	0.98	1.80	85.24	0.26555	0.0004	0.00	0.0023	0.0417	6.62	0.08	0.11
LKC -182-STM -1F1	8/22/97	0.20	0.26	1.02	0.05	1.50	0.99	0.16	0.93	1.38	70.07	0.1983	0.0002	0.00	0.0029	0.0403	5.36	0.11	0.10
LKC -195-STM -1F1	11/3/97	0.13	0.26	6.25	0.05	1.31	0.57	0.33	0.49	1.08	67.05	0.1143	0	0.00	0.0016	0	5.19	0.09	0.10

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Nd146 Conc. (µg L^{-1})	Sm147 Conc. (µg L^{-1})	W182 Conc. (µg L^{-1})	Tl205 Conc. (µg L^{-1})	Pb208 Conc. (µg L^{-1})	Cl (mg L^{-1})	NO$_3$–N (mg L^{-1})	NH$_4$–N (mg L^{-1})	Ca (mg L^{-1})	K (mg L^{-1})	Mg (mg L^{-1})	Na (mg L^{-1})	SO$_4$–S (mg L^{-1})	Si (mg L^{-1})
Nettle Brook Weir -- FILTERED															
LKC -145-STN -MF1	4/12/97						0.46	0.268	0.008	1.64	0.38	0.19	0.47	1.72	0.7
LKC -148-STN -MF1	4/20/97	0.53	0.11	0	0.002	0.03	0.28	0.389	0.014	1.57	0.37	0.15	0.47	1.57	0.62
LKC -148-STN -MF2	4/20/97	0.65	0.12	0	0.002	0.04	0.32	0.152	0.012	1.52	0.37	0.14	0.48	1.38	0.6
LKC -158-STN -MF1	6/18/97	1.16	0.22	0	0.002	0.07	0.18	0.08	0.001	1.7	0.39	0.15	0.55	1.31	0.59
LKC -162-STN -MF1	7/3/97	1.32	0.25	0.01805	0.005	0.07	0.25	0.069	0.015	2.09	0.44	0.19	0.4	1.28	0.92
LKC -166-STN -MF1	7/9/97	1.41	0.27	0	0.004	0.08	0.18	0.069	0.024	2.03	0.46	0.23	0.35	1.25	0.54
LKC -166-STN -MF2	7/9/97	1.10	0.20	0.0181	0.004	0.06	0.18	0.001	0.016	1.85	0.41	0.22	0.39	1.31	0.65
LKC -173-STN -MF1	7/15/97	1.25	0.24	0.0152	0.003	0.09	0.25	0.065	0.012	1.69	0.46	0.19	0.3	1.25	0.54
LKC -176-STN -MF1	8/13/97	1.70	0.34	0	0.003	0.11	0.18	0.001	0.001	1.72	0.47	0.2	0.29	1.12	0.74
LKC -176-STN -MF2	8/13/97	1.26	0.25	0.1132	0.007	0.07	0.18	0.001	0.001	1.7	0.42	0.19	0.28	1.22	0.69
LKC -179-STN -MF1	8/21/97	1.65	0.32	0.00865	0.005	0.11	0.18	0.001	0.001	1.47	0.47	0.17	0.29	0.99	0.79
LKC -179-STN -MF2	8/22/97	0.94	0.18	0.0121	0.004	0.05	0.35	0.001	0.001	1.5	0.41	0.17	0.32	1.22	0.78
LKC -190-STN -MF1	11/2/97	0.76	0.15	0	0.003	0.04	0.33	0.001	0.001	1.73	0.65	0.26	0.48	1.60	0.51
Upper Nettle Brook															
LKC-146-STN-UR1	4/12/97	0.50	0.11	0	0.002	0.07	0.32	0.237	0.008	1.63	0.41	0.18	0.51	1.61	0.69
LKC-149-STN-UR1	4/20/97	0.73	0.15	0	0.003	0.16	0.28	0.123	0.009	1.58	0.53	0.14	0.53	1.44	0.64
LKC-149-STN-UR2	4/20/97	0.74	0.15	0	0.002	0.12	0.32	0.2	0.005	1.46	0.38	0.13	0.47	1.38	0.6
LKC-159-STN-UR1	6/18/97	1.76	0.33	0	0.004	0.22	0.28	0.191	0.001	1.97	0.38	0.17	0.51	1.31	0.7
LKC-163-STN-UR1	7/3/97	1.98	0.39	0.0039	0.008	0.26	0.32	0.001	0.012	2.31	0.41	0.21	0.4	1.38	1
LKC-167-STN-UR1	7/9/97	1.63	0.32	0	0.006	0.27	0.21	0.03	0.02	2.02	0.42	0.22	0.33	1.28	0.55
LKC-167-STN-UR2	7/9/97	1.40	0.27	0	0.005	0.17	0.25	0.001	0.01	2.01	0.41	0.22	0.38	1.38	0.65
LKC-174-STN-UR1	7/15/97	1.95	0.36	0	0.005	0.38	0.18	0.001	0.001	1.82	0.45	0.2	0.28	1.22	0.94
LKC-177-STN-UR1	8/13/97	2.16	0.41	0	0.007	0.49	0.14	0.001	0.001	1.95	0.46	0.2	0.27	1.15	0.7
LKC-177-STN-UR2	8/13/97	1.46	0.28	0	0.005	0.22	0.18	0.001	0.005	1.8	0.42	0.19	0.28	1.34	1.04
LKC-180-STN-UR1	8/21/97	1.91	0.37	0	0.005	0.29	0.21	0.001	0.008	1.8	0.45	0.19	0.27	1.06	0.76
LKC-180-STN-UR2	8/22/97	1.28	0.25	0	0.003	0.15	0.25	0.001	0.001	1.79	0.39	0.19	0.32	1.18	0.84
LKC-191-STN-UR1	11/2/97	1.01	0.19	0	0.004	0.11	0.39	0.024	0.001	1.86	0.67	0.26	0.52	1.65	0.76
Upper Nettle Brook -- FILTERED															
LKC -146-STN -UF1	4/12/97	0.50	0.11	0.016	0.004	0.06	0.32	0.237	0.008	1.63	0.41	0.18	0.51	1.61	0.69
LKC -149-STN -UF1	4/20/97	0.66	0.12	0	0.002	0.08	0.28	0.123	0.009	1.58	0.53	0.14	0.53	1.44	0.64
LKC -149-STN -UF2	4/20/97	0.71	0.14	0	0.003	0.08	0.32	0.2	0.005	1.46	0.38	0.13	0.47	1.38	0.6
LKC -159-STN -UF1	6/18/97	1.64	0.31	0.005	0.005	0.18	0.28	0.191	0.001	1.97	0.38	0.17	0.51	1.31	0.7
LKC -163-STN -UF1	7/3/97	1.71	0.33	0.0263	0.009	0.16	0.32	0.001	0.012	2.31	0.41	0.21	0.4	1.38	1
LKC -167-STN -UF1	7/9/97	1.48	0.29	0.0049	0.008	0.14	0.21	0.03	0.02	2.02	0.42	0.22	0.33	1.28	0.55
LKC -167-STN -UF2	7/9/97	1.31	0.26	0	0.005	0.12	0.25	0.001	0.01	2.01	0.41	0.22	0.38	1.38	0.65
LKC -174-STN -UF1	7/15/97	1.72	0.31	0.0119	0.005	0.22	0.18	0.001	0.001	1.82	0.45	0.2	0.28	1.22	0.94
LKC -177-STN -UF1	8/13/97	1.69	0.32	0	0.007	0.19	0.14	0.001	0.001	1.95	0.46	0.2	0.27	1.15	0.7
LKC -177-STN -UF2	8/13/97	1.35	0.25	0	0.004	0.14	0.18	0.001	0.005	1.8	0.42	0.19	0.28	1.34	1.04
LKC -180-STN -UF1	8/21/97	1.81	0.34	0	0.006	0.19	0.21	0.001	0.008	1.8	0.45	0.19	0.27	1.06	0.76
LKC -180-STN -UF2	8/22/97	1.18	0.23	0.0253	0.004	0.09	0.25	0.001	0.001	1.79	0.39	0.19	0.32	1.18	0.84
LKC -191-STN -UF1	11/2/97	0.88	0.17	0	0.002	0.10	0.39	0.024	0.001	1.86	0.67	0.26	0.52	1.65	0.76

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Nd146 Conc. (µg L^{-1})	Sm147 Conc. (µg L^{-1})	W182 Conc. (µg L^{-1})	Tl205 Conc. (µg L^{-1})	Pb208 Conc. (µg L^{-1})	Cl (mg L^{-1})	NO$_3$–N (mg L^{-1})	NH$_4$–N (mg L^{-1})	Ca (mg L^{-1})	K (mg L^{-1})	Mg (mg L^{-1})	Na (mg L^{-1})	SO$_4$–S (mg L^{-1})	Si (mg L^{-1})
Nettle Brook Weir															
LKC-153-STT-1R2	4/25/97	1.60	0.29	0	0.009	0.23	0.32	0.642	0.001	0.35	0.39	0.11	0.38	1.31	0.44
LKC-160-STT-1R1	6/18/97	2.00	0.37	0	0.009	0.35	0.35	0.032	0.001	0.27	0.37	0.06	0.35	1.28	0.58
LKC-160-STT-1R2	6/19/97	2.18	0.38	0	0.008	0.37	0.18	0.224	0.006	0.41	0.36	0.07	0.36	1.22	0.49
LKC-164-STT-1R1	7/3/97	1.94	0.36	0	0.009	0.31	0.25	0.009	0.008	0.3	0.51	0.06	0.28	1.38	0.57
LKC-164-STT-1R2	7/4/97	2.24	0.42	0	0.009	0.36	0.14	0.055	0.062	0.28	0.3	0.07	0.21	1.38	0.63
LKC-168-STT-1R1	7/9/97	2.41	0.45	0	0.011	0.61	0.25	0.068	0.056	0.41	0.35	0.14	0.2	1.44	0.44
LKC-181-STT-1R1	8/21/97	2.62	0.47	0.0005	0.010	0.56	0.21	0.001	0.009	0.29	0.48	0.11	0.25	1.34	0.53
LKC-187-STT-1R1	9/20/97	2.07	0.40	0	0.012	0.34	0.22	0.144	0.001	0.43	0.50	0.16	0.36	1.63	0.78
LKC-187-STT-1R2	9/20/97	2.28	0.43	0	0.009	0.37	0.21	0.001	0.007	0.44	0.50	0.17	0.36	1.63	0.51
LKC-188-STT-1R1	9/23/97	2.05	0.39	0	0.010	0.31	0.25	0.001	0.006	0.40	0.50	0.16	0.37	1.62	0.46
LKC-188-STT-1R2	9/23/97	2.29	0.43	0	0.010	0.35	0.25	0.001	0.001	0.41	0.49	0.17	0.38	1.63	0.48
LKC-192-STT-1R1	11/1/97	2.15	0.40	0	0.015	0.39	0.36	0.177	0.001	0.46	0.54	0.21	0.37	1.57	0.42
LKC-192-STT-1R2	11/2/97	2.04	0.40	0	0.012	0.36	0.36	0.104	0.001	0.43	0.51	0.18	0.34	1.56	0.33
Stream 10 -- FILTERED															
LKC -153-STT -1F2	4/25/97	1.66	0.30	0	0.011	0.25	0.32	0.642	0.001	0.35	0.39	0.11	0.38	1.31	0.44
LKC -160-STT -1F1	6/18/97	1.98	0.37	0	0.008	0.30	0.35	0.032	0.001	0.27	0.37	0.06	0.35	1.28	0.58
LKC -160-STT -1F2	6/19/97	2.15	0.40	0	0.010	0.33	0.18	0.224	0.006	0.41	0.36	0.07	0.36	1.22	0.49
LKC -164-STT -1F1	7/3/97	1.92	0.35	0	0.009	0.30	0.25	0.009	0.008	0.3	0.51	0.06	0.28	1.38	0.57
LKC -164-STT -1F2	7/4/97	2.22	0.41	0.00465	0.010	0.35	0.14	0.055	0.062	0.28	0.3	0.07	0.21	1.38	0.63
LKC -168-STT -1F1	7/9/97	2.31	0.43	0.0507	0.010	0.49	0.25	0.068	0.056	0.41	0.35	0.14	0.2	1.44	0.44
LKC -181-STT -1F1	8/21/97	2.41	0.44	0.0128	0.011	0.42	0.21	0.001	0.009	0.29	0.48	0.11	0.25	1.34	0.53
LKC -187-STT -1F1	9/20/97	2.00	0.38	0.0082	0.011	0.32	0.22	0.144	0.001	0.43	0.50	0.16	0.36	1.63	0.78
LKC -187-STT -1F2	9/20/97	2.22	0.41	0	0.010	0.34	0.21	0.001	0.007	0.44	0.50	0.17	0.36	1.63	0.51
LKC -188-STT -1F1	9/23/97	2.00	0.37	0	0.010	0.28	0.25	0.001	0.006	0.40	0.50	0.16	0.37	1.62	0.46
LKC -188-STT -1F2	9/23/97	2.25	0.42	0	0.010	0.32	0.25	0.001	0.001	0.41	0.49	0.17	0.38	1.63	0.48
LKC -192-STT -1F1	11/1/97	2.11	0.40	0.0502	0.016	0.32	0.36	0.177	0.001	0.46	0.54	0.21	0.37	1.57	0.42
LKC -192-STT -1F2	11/2/97	2.13	0.39	0.01215	0.012	0.37	0.36	0.104	0.001	0.43	0.51	0.18	0.34	1.56	0.33
Lamoille River at Jeffersonville															
LKC-155-STJ-1R1	4/21/97	0.57	0.11	0	0.006	0.41									
LKC-169-STJ-1R1	7/10/97	1.34	0.27	0	0,009	1.15	7.27	0.175	0.001	13.65	1.08	2.4	3.74	1.98	1.42
LKC-184-STJ-1R1	8/22/97	0.68	0.12	0	0.006	0.41	6.74	0.1	0.001	10.11	0.94	1.83	3.4	1.79	1.11
LKC-193-STJ-1R1	11/3/97	0.71	0.12	0	0.010	0.45	5.67	0.131	0.001	9.00	1.05	1.64	2.39	2.08	0.85
Lamoille River at Jeffersonville -- FILTERED															
LKC -155-STJ -1F1	4/21/97	0.17	0.03	0.002	0.005	0.05									
LKC -169-STJ -1F1	7/10/97	0.17	0.03	0.014	0.006	0.09	7.27	0.175	0.001	13.65	1.08	2.4	3.74	1.98	1.42
LKC -184-STJ -1F1	8/22/97	0.28	0.06	0	0.006	0.10	6.74	0.1	0.001	10.11	0.94	1.83	3.4	1.79	1.11
LKC -193-STJ -1F1	11/3/97	0.23	0.04	0.0078	0.010	0.10	5.67	0.131	0.001	9.00	1.05	1.64	2.39	2.08	0.85

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-5. Summary statistics for each analyte by media and site.

Al

Aluminum Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	899.67	247.40	489.23	1142.92
		dissolved	3	870.12	359.05	470.81	1166.36
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	90.93	30.40	56.89	115.38
		dissolved	3	68.59	26.54	51.98	99.20
	deep	*total*	3	61.00	38.07	24.35	100.35
		dissolved	3	59.79	40.75	20.83	102.11
Stream 10	shallow	*total*	3	1220.54	578.92	554.05	1598.41
		dissolved	2	1515.53	135.14	1419.97	1611.09
	deep	*total*	2	650.10	186.17	518.46	781.75
		dissolved	2	618.71	236.84	451.24	786.18

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	104.61	56.95	49.08	233.51
	dissolved	13	64.33	21.38	37.86	101.14
Mid Nettle	*total*	13	114.10	31.84	64.82	168.51
	dissolved	12	100.46	25.22	58.36	137.27
Upper Nettle	*total*	13	117.48	35.31	61.65	159.49
	dissolved	13	108.65	31.59	62.18	150.07
Stream 10	*total*	13	444.51	57.00	340.41	541.16
	dissolved	13	443.87	55.99	354.10	517.19
Jeffersonville	*total*	3	117.13	30.27	92.80	151.04
	dissolved	4	26.67	2.47	23.94	29.90
Browns River	*total*	3	169.79	165.25	24.91	349.78
	dissolved	3	93.06	126.84	11.40	239.19
Milton	*total*	4	118.27	78.61	34.88	193.99
	dissolved	4	17.92	6.00	12.87	26.33

Table B-4. Stream water concentrations -- complete data set

Sample ID	Collection date	Nd146 Conc. (µg L⁻¹)	Sm147 Conc. (µg L⁻¹)	W182 Conc. (µg L⁻¹)	Tl205 Conc. (µg L⁻¹)	Pb208 Conc. (µg L⁻¹)	Cl (mg L⁻¹)	NO_3–N (mg L⁻¹)	NH_4–N (mg L⁻¹)	Ca (mg L⁻¹)	K (mg L⁻¹)	Mg (mg L⁻¹)	Na (mg L⁻¹)	SO_4–S (mg L⁻¹)	Si (mg L⁻¹)
Browns River at Fairfax															
LKC-154-STB-1R1	4/21/97														
LKC-170-STB-1R1	7/10/97	0.30	0.06	0	0.008	0.09	6.56	0.256	0.009	8.96	1.04	1.67	3.41	1.92	1.21
LKC-183-STB-1R1	8/22/97	0.77	0.17	0	0.018	0.48	17.37	0.267	0.001	16.72	1.55	3.21	7.88	2.37	1.47
LKC-194-STB-1R1	11/3/97	3.24	0.67	0	0.010	1.87	4.79	0.083	0.007	7.12	1.36	1.38	2.05	2.06	0.83
Browns River at Fairfax -- FILTERED															
LKC -154-STB -FLT	4/21/97														
LKC -170-STB -1F1	7/10/97	1.54	0.30	0	0.010	0.79	6.56	0.256	0.009	8.96	1.04	1.67	3.41	1.92	1.21
LKC -183-STB -1F1	8/22/97	0.08	0.02	0.0114	0.014	0.04	17.37	0.267	0.001	16.72	1.55	3.21	7.88	2.37	1.47
LKC -194-STB -1F1	11/3/97	0.35	0.07	0	0.006	0.06	4.79	0.083	0.007	7.12	1.36	1.38	2.05	2.06	0.83
Lamoille River at Milton															
LKC-156-STM-1R1	4/21/97	0.62	0.13	0	0.006	0.42									
LKC-171-STM-1R1	7/10/97	0.49	0.10	0.0006	0.011	0.33	8.86	0.43	0.001	15.96	1.69	3.07	6.55	2.53	1.21
LKC-182-STM-1R1	8/22/97	0.20	0.04	0	0.005	0.13	11.70	0.227	0.001	13.39	1.39	2.55	5.14	2.24	1.16
LKC-195-STM-1R1	11/3/97	0.36	0.07	0	0.014	0.27	8.51	0.186	0.001	12.77	1.66	2.47	4.19	2.52	0.95
Lamoille River at Milton -- FILTERED															
LKC -156-STM -1F1	4/21/97	0.17	0.04	0	0.004	0.06									
LKC -171-STM -1F1	7/10/97	0.08	0.02	0.00995	0.010	0.05	8.86	0.43	0.001	15.96	1.69	3.07	6.55	2.53	1.21
LKC -182-STM -1F1	8/22/97	0.11	0.02	0.0116	0.006	0.06	11.70	0.227	0.001	13.39	1.39	2.55	5.14	2.24	1.16
LKC -195-STM -1F1	11/3/97	0.09	0.02	0.0129	0.016	0.06	8.51	0.186	0.001	12.77	1.66	2.47	4.19	2.52	0.95

† Shaded values are total concentrations. Filtered value was discarded because filtered > total.

Table B-5. Summary statistics for each analyte by media and site.

Sb

Antimony Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.062	0.041	0.001	0.107
		dissolved	3	0.059	0.050	0.001	0.088
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.009	0.008	0.000	0.014
		dissolved	3	0.020	0.017	0.000	0.031
	deep	*total*	3	0.000	0.000	0.000	0.000
		dissolved	3	0.040	0.046	0.000	0.091
Stream 10	shallow	*total*	3	0.052	0.025	0.024	0.070
		dissolved	2	0.129	0.068	0.081	0.177
	deep	*total*	2	0.008	0.011	0.000	0.016
		dissolved	2	0.046	0.031	0.025	0.068
Stream Water							
Nettle Weir		*total*	12	0.003	0.005	0.000	0.016
		dissolved	13	0.021	0.033	0.000	0.120
Mid Nettle		*total*	13	0.004	0.007	0.000	0.018
		dissolved	12	0.022	0.040	0.000	0.144
Upper Nettle		*total*	13	0.007	0.010	0.000	0.033
		dissolved	13	0.013	0.013	0.000	0.040
Stream 10		*total*	13	0.029	0.026	0.000	0.072
		dissolved	13	0.043	0.036	0.000	0.128
Jeffersonville		*total*	4	0.010	0.011	0.000	0.021
		dissolved	4	0.017	0.021	0.000	0.042
Browns River		*total*	3	0.012	0.020	0.000	0.035
		dissolved	3	0.019	0.023	0.000	0.044
Milton		*total*	4	0.013	0.015	0.000	0.030
		dissolved	4	0.021	0.023	0.000	0.042

Table B-5. Summary statistics for each analyte by media and site.

NH_4-N

Ammonium Units are in (mg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*dissolved*	10	0.018	0.010	0.001	0.038
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	0.015	0.023	0.001	0.064
	deep	*dissolved*	8	0.010	0.015	0.001	0.042
Stream 10	shallow	*dissolved*	6	0.097	0.099	0.019	0.286
	deep	*dissolved*	3	0.011	0.001	0.010	0.011
Stream Water							
Nettle Weir		*dissolved*	13	0.012	0.014	0.001	0.053
Mid Nettle		*dissolved*	13	0.008	0.008	0.001	0.024
Upper Nettle		*dissolved*	13	0.006	0.006	0.001	0.020
Stream 10		*dissolved*	13	0.012	0.021	0.001	0.062
Jeffersonville		*dissolved*	3	0.001	0.000	0.001	0.001
Browns River		*dissolved*	3	0.006	0.004	0.001	0.009
Milton		*dissolved*	3	0.001	0.000	0.001	0.001

Table B-5. Summary statistics for each analyte by media and site.

Ba

Barium

Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	33.91	25.65	4.06	68.68
		dissolved	3	39.86	26.30	13.64	66.23
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	11.88	1.58	10.94	13.71
		dissolved	3	11.71	1.95	10.32	13.95
	deep	*total*	3	9.71	8.10	0.43	15.36
		dissolved	3	9.70	8.09	0.46	15.54
Stream 10	shallow	*total*	3	9.31	4.46	6.33	14.43
		dissolved	2	11.04	5.28	7.31	14.77
	deep	*total*	2	5.38	0.86	4.78	5.99
		dissolved	2	5.39	1.06	4.64	6.14
Stream Water							
Nettle Weir		*total*	12	11.88	1.64	10.05	15.54
		dissolved	13	10.86	1.10	9.51	13.39
Mid Nettle		*total*	13	12.62	1.65	10.64	16.34
		dissolved	12	12.23	1.61	10.46	15.81
Upper Nettle		*total*	13	13.25	1.68	10.95	16.15
		dissolved	13	12.98	1.48	10.99	15.39
Stream 10		*total*	13	3.48	0.15	3.27	3.73
		dissolved	13	3.49	0.19	3.24	3.88
Jeffersonville		*total*	4	6.41	1.86	5.06	9.15
		dissolved	4	4.51	0.56	3.75	5.10
Browns River		*total*	3	9.57	3.44	5.74	12.40
		dissolved	3	7.39	2.02	5.20	9.18
Milton		*total*	4	6.75	1.25	5.79	8.58
		dissolved	4	5.41	0.89	4.49	6.62

Table B-5. Summary statistics for each analyte by media and site.

As

Arsenic

Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.278	0.049	0.214	0.350
		dissolved	3	0.247	0.045	0.196	0.280
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.068	0.024	0.049	0.094
		dissolved	3	0.067	0.033	0.033	0.098
	deep	*total*	3	0.053	0.029	0.020	0.074
		dissolved	3	0.058	0.030	0.026	0.085
Stream 10	shallow	*total*	3	0.209	0.023	0.182	0.224
		dissolved	2	0.236	0.008	0.230	0.242
	deep	*total*	2	0.170	0.020	0.155	0.184
		dissolved	2	0.165	0.011	0.158	0.173
Stream Water							
Nettle Weir		*total*	12	0.098	0.040	0.033	0.184
		dissolved	13	0.081	0.027	0.037	0.120
Mid Nettle		*total*	13	0.091	0.030	0.045	0.146
		dissolved	12	0.090	0.026	0.049	0.130
Upper Nettle		*total*	13	0.107	0.040	0.035	0.148
		dissolved	13	0.108	0.042	0.045	0.174
Stream 10		*total*	13	0.200	0.041	0.117	0.266
		dissolved	13	0.198	0.035	0.139	0.258
Jeffersonville		*total*	4	0.837	0.414	0.525	1.445
		dissolved	4	0.489	0.203	0.286	0.732
Browns River		*total*	3	0.326	0.098	0.237	0.432
		dissolved	3	0.257	0.117	0.163	0.387
Milton		*total*	4	0.854	0.392	0.465	1.335
		dissolved	4	0.685	0.314	0.350	0.976

Table B-5. Summary statistics for each analyte by media and site.

Cd

Cadmium Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.373	0.284	0.114	0.778
		dissolved	3	0.422	0.314	0.140	0.760
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.162	0.055	0.103	0.211
		dissolved	3	0.168	0.049	0.117	0.215
	deep	*total*	3	0.113	0.002	0.112	0.115
		dissolved	3	0.127	0.007	0.120	0.133
Stream 10	shallow	*total*	3	0.155	0.064	0.105	0.228
		dissolved	2	0.178	0.070	0.129	0.228
	deep	*total*	2	0.118	0.032	0.095	0.141
		dissolved	2	0.121	0.037	0.095	0.147

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.042	0.016	0.022	0.078
	dissolved	13	0.031	0.006	0.023	0.049
Mid Nettle	*total*	13	0.060	0.015	0.043	0.092
	dissolved	12	0.053	0.011	0.040	0.072
Upper Nettle	*total*	13	0.060	0.014	0.039	0.082
	dissolved	13	0.054	0.010	0.040	0.076
Stream 10	*total*	13	0.144	0.015	0.119	0.175
	dissolved	13	0.148	0.017	0.125	0.172
Jeffersonville	*total*	4	0.022	0.006	0.016	0.030
	dissolved	4	0.007	0.008	0.000	0.018
Browns River	*total*	3	0.025	0.027	0.007	0.056
	dissolved	3	0.009	0.012	0.002	0.023
Milton	*total*	4	0.007	0.003	0.004	0.011
	dissolved	4	0.002	0.002	0.001	0.005

Table B-5. Summary statistics for each analyte by media and site.

Be

Beryllium Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.054	0.029	0.025	0.090
		dissolved	3	0.060	0.033	0.021	0.081
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.082	0.022	0.060	0.104
		dissolved	3	0.073	0.031	0.037	0.092
	deep	*total*	3	0.132	0.070	0.054	0.188
		dissolved	3	0.146	0.085	0.056	0.225
Stream 10	shallow	*total*	3	0.046	0.030	0.023	0.080
		dissolved	2	0.073	0.002	0.072	0.074
	deep	*total*	2	0.035	0.020	0.020	0.049
		dissolved	2	0.041	0.009	0.035	0.048

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.033	0.012	0.010	0.047
	dissolved	13	0.021	0.007	0.011	0.033
Mid Nettle	*total*	13	0.042	0.018	0.013	0.073
	dissolved	12	0.038	0.014	0.022	0.063
Upper Nettle	*total*	13	0.045	0.012	0.030	0.064
	dissolved	13	0.039	0.015	0.021	0.068
Stream 10	*total*	13	0.031	0.014	0.008	0.053
	dissolved	13	0.031	0.009	0.015	0.044
Jeffersonville	*total*	4	0.009	0.015	0.000	0.031
	dissolved	4	0.011	0.012	0.000	0.027
Browns River	*total*	3	0.022	0.018	0.002	0.037
	dissolved	3	0.017	0.029	0.000	0.051
Milton	*total*	4	0.013	0.015	0.001	0.033
	dissolved	4	0.010	0.013	0.000	0.029

Table B-5. Summary statistics for each analyte by media and site.

Ce

Cerium

Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.94	0.16	0.80	1.16
		dissolved	3	0.79	0.05	0.75	0.84
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.84	0.49	0.39	1.37
		dissolved	3	0.56	0.56	0.11	1.19
	deep	*total*	3	0.25	0.20	0.05	0.45
		dissolved	3	0.25	0.20	0.04	0.45
Stream 10	shallow	*total*	3	3.06	1.06	2.08	4.19
		dissolved	2	3.38	0.75	2.86	3.91
	deep	*total*	2	1.90	0.47	1.57	2.24
		dissolved	2	1.80	0.61	1.36	2.23
Stream Water							
Nettle Weir		*total*	12	0.67	0.51	0.20	1.90
		dissolved	13	0.29	0.12	0.10	0.45
Mid Nettle		*total*	13	0.51	0.21	0.19	0.84
		dissolved	12	0.41	0.15	0.19	0.67
Upper Nettle		*total*	13	0.56	0.22	0.19	0.88
		dissolved	13	0.49	0.18	0.18	0.70
Stream 10		*total*	13	3.51	0.43	2.60	4.32
		dissolved	13	3.44	0.33	2.73	3.95
Jeffersonville		*total*	4	1.44	0.84	0.98	2.70
		dissolved	4	0.21	0.03	0.18	0.24
Browns River		*total*	3	2.20	2.50	0.28	5.03
		dissolved	3	0.90	1.21	0.08	2.29
Milton		*total*	4	0.72	0.35	0.27	1.03
		dissolved	4	0.13	0.04	0.10	0.19

Table B-5. Summary statistics for each analyte by media and site.

Ca

Calcium

Units are in (mg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*dissolved*	10	8.49	4.53	3.52	18.32
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	4.78	2.99	1.87	10.40
	deep	*dissolved*	8	3.21	2.98	1.16	9.51
Stream 10	shallow	*dissolved*	6	2.21	1.16	0.46	3.95
	deep	*dissolved*	3	2.37	1.57	0.80	3.93
Stream Water							
Nettle Weir		*dissolved*	13	2.41	0.41	1.83	3.29
Mid Nettle		*dissolved*	13	1.71	0.19	1.47	2.09
Upper Nettle		*dissolved*	13	1.85	0.22	1.46	2.31
Stream 10		*dissolved*	13	0.38	0.07	0.27	0.46
Jeffersonville		*dissolved*	3	10.92	2.43	9.00	13.65
Browns River		*dissolved*	3	10.93	5.10	7.12	16.72
Milton		*dissolved*	3	14.04	1.69	12.77	15.96

Table B-5. Summary statistics for each analyte by media and site.

Cr

Chromium Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.607	0.261	0.370	1.021
		dissolved	3	0.413	0.069	0.366	0.492
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.137	0.052	0.079	0.179
		dissolved	3	0.132	0.097	0.025	0.213
	deep	*total*	3	0.050	0.029	0.017	0.074
		dissolved	3	0.062	0.014	0.053	0.078
Stream 10	shallow	*total*	3	0.318	0.077	0.261	0.406
		dissolved	2	0.290	0.077	0.235	0.345
	deep	*total*	2	0.438	0.062	0.394	0.481
		dissolved	2	0.414	0.032	0.392	0.437

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.105	0.063	0.008	0.255
	dissolved	13	0.063	0.036	0.001	0.099
Mid Nettle	*total*	13	0.090	0.047	0.010	0.181
	dissolved	12	0.083	0.036	0.000	0.141
Upper Nettle	*total*	13	0.102	0.044	0.023	0.161
	dissolved	13	0.093	0.048	0.000	0.158
Stream 10	*total*	13	0.294	0.051	0.177	0.382
	dissolved	13	0.290	0.050	0.209	0.389
Jeffersonville	*total*	4	0.566	0.311	0.358	1.022
	dissolved	4	0.261	0.053	0.218	0.336
Browns River	*total*	3	0.376	0.145	0.209	0.466
	dissolved	3	0.263	0.163	0.125	0.443
Milton	*total*	4	0.488	0.177	0.304	0.686
	dissolved	4	0.287	0.035	0.260	0.335

Table B-5. Summary statistics for each analyte by media and site.

Cl-

Chloride Units are in (mg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*dissolved*	10	0.34	0.24	0.14	0.95
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	0.27	0.09	0.18	0.36
	deep	*dissolved*	8	0.34	0.05	0.25	0.43
Stream 10	shallow	*dissolved*	6	0.85	0.54	0.33	1.71
	deep	*dissolved*	3	0.48	0.05	0.44	0.54

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*dissolved*	13	0.25	0.09	0.14	0.41
Mid Nettle	*dissolved*	13	0.26	0.09	0.18	0.46
Upper Nettle	*dissolved*	13	0.26	0.07	0.14	0.39
Stream 10	*dissolved*	13	0.26	0.07	0.14	0.36
Jeffersonville	*dissolved*	3	6.56	0.82	5.67	7.27
Browns River	*dissolved*	3	9.57	6.81	4.79	17.37
Milton	*dissolved*	3	9.69	1.75	8.51	11.70

Table B-5. Summary statistics for each analyte by media and site.

Color

Units are in (mg/L PtCo)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*dissolved*	10	376.26	92.40	262.57	502.49
	deep	*dissolved*	1	19.61	.	19.61	19.61
Upper Nettle	shallow	*dissolved*	7	14.82	8.34	9.16	32.67
	deep	*dissolved*	9	5.97	2.69	2.62	9.16
Stream 10	shallow	*dissolved*	6	181.44	67.58	119.32	264.75
	deep	*dissolved*	3	56.62	27.72	37.46	88.41

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*dissolved*	13	43.86	18.61	12.21	70.12
Mid Nettle	*dissolved*	13	42.25	19.61	10.90	79.70
Upper Nettle	*dissolved*	13	53.54	21.12	14.82	80.57
Stream 10	*dissolved*	13	28.92	8.78	14.39	44.86
Jeffersonville	*dissolved*	3	49.80	11.76	37.90	61.41
Browns River	*dissolved*	3	42.69	15.68	25.71	56.62
Milton	*dissolved*	3	35.28	9.37	26.14	44.86

Table B-5. Summary statistics for each analyte by media and site.

Co

Cobalt

Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.565	0.333	0.221	0.967
		dissolved	3	0.596	0.358	0.259	0.971
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.076	0.028	0.058	0.108
		dissolved	3	0.058	0.003	0.055	0.062
	deep	*total*	3	0.046	0.006	0.041	0.053
		dissolved	3	0.044	0.007	0.039	0.051
Stream 10	shallow	*total*	3	0.467	0.181	0.359	0.675
		dissolved	2	0.538	0.240	0.368	0.707
	deep	*total*	2	0.547	0.231	0.384	0.711
		dissolved	2	0.544	0.239	0.375	0.713

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.148	0.116	0.046	0.433
	dissolved	13	0.046	0.013	0.024	0.062
Mid Nettle	*total*	13	0.117	0.065	0.054	0.301
	dissolved	12	0.067	0.020	0.045	0.115
Upper Nettle	*total*	13	0.348	0.150	0.122	0.581
	dissolved	13	0.300	0.119	0.115	0.477
Stream 10	*total*	13	0.755	0.101	0.615	0.949
	dissolved	13	0.753	0.105	0.607	0.975
Jeffersonville	*total*	4	0.432	0.282	0.254	0.854
	dissolved	4	0.056	0.010	0.041	0.063
Browns River	*total*	3	0.447	0.463	0.057	0.958
	dissolved	3	0.184	0.219	0.051	0.437
Milton	*total*	4	0.209	0.089	0.088	0.283
	dissolved	4	0.055	0.009	0.048	0.068

Table B-5. Summary statistics for each analyte by media and site.

Cu

Copper

Units are in (μg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	1.76	0.43	1.44	2.36
		dissolved	3	1.45	0.14	1.34	1.60
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.64	0.20	0.45	0.85
		dissolved	3	0.57	0.21	0.33	0.75
	deep	*total*	3	0.47	0.20	0.25	0.60
		dissolved	3	0.47	0.20	0.24	0.62
Stream 10	shallow	*total*	3	1.84	0.13	1.70	1.96
		dissolved	2	1.70	0.07	1.65	1.75
	deep	*total*	2	1.26	0.07	1.21	1.31
		dissolved	2	1.20	0.12	1.12	1.28
Stream Water							
Nettle Weir		*total*	12	0.52	0.17	0.26	0.87
		dissolved	13	0.42	0.12	0.21	0.61
Mid Nettle		*total*	13	0.49	0.14	0.26	0.73
		dissolved	12	0.47	0.12	0.29	0.64
Upper Nettle		*total*	13	0.48	0.15	0.26	0.69
		dissolved	13	0.47	0.14	0.22	0.64
Stream 10		*total*	13	2.89	0.30	2.20	3.43
		dissolved	13	2.82	0.26	2.21	3.14
Jeffersonville		*total*	4	1.25	0.40	0.92	1.84
		dissolved	4	0.83	0.17	0.58	0.94
Browns River		*total*	3	1.36	0.72	0.94	2.18
		dissolved	3	1.00	0.49	0.57	1.53
Milton		*total*	4	1.02	0.23	0.77	1.32
		dissolved	4	0.82	0.26	0.57	1.11

Table B-5. Summary statistics for each analyte by media and site.

Conductivity

Units are in (μ mho)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	9	56.0	22.0	29.0	94.3
	deep	*total*	3	22.5	12.5	11.6	36.1
Upper Nettle	shallow	*total*	7	35.9	21.5	19.6	74.4
	deep	*total*	8	25.7	15.3	13.9	53.8
Stream 10	shallow	*total*	5	32.7	9.9	22.6	46.2
	deep	*total*	2	24.1	1.8	22.8	25.4
Stream Water							
Nettle Weir		*total*	9	19.4	3.5	15.4	25.6
Mid Nettle		*total*	9	14.2	2.5	11.9	19.4
Upper Nettle		*total*	9	15.0	1.3	13.3	17.3
Stream 10		*total*	10	25.5	2.2	23.4	29.6
Jeffersonville		*total*	3	84.7	13.7	75.0	100.4
Browns River		*total*	3	93.3	42.6	63.3	142.0
Milton		*total*	3	117.6	16.0	107.9	136.1

Table B-5. Summary statistics for each analyte by media and site.

In

Indium Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.0013	0.0017	0.0000	0.0042
		dissolved	3	0.0030	0.0038	0.0007	0.0073
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.0000	0.0000	0.0000	0.0000
		dissolved	3	0.0021	0.0014	0.0006	0.0033
	deep	*total*	3	0.0001	0.0001	0.0000	0.0002
		dissolved	3	0.0114	0.0147	0.0000	0.0279
Stream 10	shallow	*total*	3	0.0018	0.0015	0.0002	0.0031
		dissolved	2	0.0131	0.0141	0.0031	0.0230
	deep	*total*	2	0.0009	0.0010	0.0002	0.0016
		dissolved	2	0.0064	0.0042	0.0034	0.0094

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.0004	0.0007	0.0000	0.0025
	dissolved	13	0.0049	0.0059	0.0000	0.0216
Mid Nettle	*total*	13	0.0002	0.0004	0.0000	0.0012
	dissolved	12	0.0033	0.0059	0.0000	0.0213
Upper Nettle	*total*	13	0.0002	0.0004	0.0000	0.0011
	dissolved	13	0.0015	0.0016	0.0000	0.0047
Stream 10	*total*	13	0.0002	0.0003	0.0000	0.0010
	dissolved	13	0.0033	0.0034	0.0000	0.0112
Jeffersonville	*total*	4	0.0003	0.0006	0.0000	0.0012
	dissolved	4	0.0009	0.0011	0.0000	0.0026
Browns River	*total*	3	0.0000	0.0000	0.0000	0.0000
	dissolved	3	0.0019	0.0016	0.0000	0.0031
Milton	*total*	4	0.0001	0.0002	0.0000	0.0003
	dissolved	4	0.0019	0.0009	0.0009	0.0029

Table B-5. Summary statistics for each analyte by media and site.

DOC

Dissolved Organic Carbon Units are in (mg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*dissolved*	12	22.73	7.73	9.47	36.09
	deep	*dissolved*	2	2.39	0.40	2.10	2.67
Upper Nettle	shallow	*dissolved*	8	2.53	1.02	1.00	4.51
	deep	*dissolved*	8	0.55	0.34	0.30	1.19
Stream 10	shallow	*dissolved*	6	18.77	5.06	13.78	26.11
	deep	*dissolved*	3	11.25	5.52	5.63	16.67

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*dissolved*	13	3.89	1.52	1.50	6.18
Mid Nettle	*dissolved*	13	4.11	1.59	1.68	6.64
Upper Nettle	*dissolved*	13	4.77	1.87	1.63	7.10
Stream 10	*dissolved*	13	4.40	1.02	2.10	5.79
Jeffersonville	*dissolved*	3	5.10	0.97	3.99	5.71
Browns River	*dissolved*	3	4.44	1.15	3.14	5.32
Milton	*dissolved*	3	4.49	1.03	3.37	5.40

Table B-5. Summary statistics for each analyte by media and site.

Pb

Lead Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	1.072	0.296	0.705	1.511
		dissolved	3	0.882	0.217	0.668	1.102
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.106	0.113	0.009	0.230
		dissolved	3	0.029	0.029	0.009	0.062
	deep	*total*	3	0.009	0.006	0.005	0.015
		dissolved	3	0.008	0.003	0.005	0.011
Stream 10	shallow	*total*	3	1.891	1.242	1.019	3.314
		dissolved	2	1.977	1.415	0.976	2.977
	deep	*total*	2	0.507	0.355	0.255	0.758
		dissolved	2	0.420	0.374	0.155	0.684
Stream Water							
Nettle Weir		*total*	12	0.280	0.299	0.055	1.087
		dissolved	13	0.045	0.022	0.014	0.080
Mid Nettle		*total*	13	0.149	0.099	0.046	0.429
		dissolved	12	0.067	0.027	0.030	0.114
Upper Nettle		*total*	13	0.224	0.116	0.074	0.488
		dissolved	13	0.135	0.051	0.064	0.223
Stream 10		*total*	13	0.377	0.101	0.234	0.615
		dissolved	13	0.338	0.064	0.247	0.494
Jeffersonville		*total*	4	0.608	0.364	0.413	1.153
		dissolved	4	0.087	0.024	0.052	0.104
Browns River		*total*	3	0.812	0.935	0.092	1.868
		dissolved	3	0.301	0.427	0.045	0.794
Milton		*total*	4	0.290	0.121	0.134	0.421
		dissolved	4	0.059	0.007	0.049	0.065

Table B-5. Summary statistics for each analyte by media and site.

La

Lanthanum Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.51	0.10	0.44	0.66
		dissolved	3	0.43	0.02	0.42	0.44
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	2.08	1.24	0.65	2.89
		dissolved	3	1.56	0.84	0.63	2.28
	deep	*total*	3	19.75	13.74	3.89	27.93
		dissolved	3	19.57	13.81	3.62	27.61
Stream 10	shallow	*total*	3	1.59	0.49	1.14	2.12
		dissolved	2	1.70	0.32	1.48	1.93
	deep	*total*	2	0.97	0.29	0.77	1.18
		dissolved	2	0.93	0.32	0.70	1.16
Stream Water							
Nettle Weir		*total*	12	1.01	0.54	0.37	1.96
		dissolved	13	0.63	0.27	0.25	1.05
Mid Nettle		*total*	13	1.32	0.55	0.49	2.31
		dissolved	12	1.18	0.43	0.54	1.95
Upper Nettle		*total*	13	1.51	0.59	0.51	2.36
		dissolved	13	1.35	0.51	0.48	1.98
Stream 10		*total*	13	2.36	0.27	1.80	2.88
		dissolved	13	2.29	0.22	1.84	2.61
Jeffersonville		*total*	4	0.85	0.34	0.59	1.35
		dissolved	4	0.22	0.06	0.16	0.29
Browns River		*total*	3	1.35	1.52	0.27	3.09
		dissolved	3	0.61	0.71	0.07	1.42
Milton		*total*	4	0.40	0.17	0.19	0.59
		dissolved	4	0.11	0.04	0.08	0.17

Table B-5. Summary statistics for each analyte by media and site.

Mg

Magnesium (UMAQL) Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	550.57	229.80	222.55	832.04
		dissolved	3	523.64	289.98	220.85	798.84
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	370.58	211.92	217.15	612.38
		dissolved	3	375.12	230.00	209.06	637.64
	deep	*total*	3	185.29	15.40	174.94	202.98
		dissolved	3	188.32	16.36	175.68	206.81
Stream 10	shallow	*total*	3	131.66	71.19	52.10	189.37
		dissolved	2	122.72	99.15	52.61	192.83
	deep	*total*	2	196.60	152.62	88.69	304.52
		dissolved	2	199.77	156.36	89.20	310.33
Stream Water							
Nettle Weir		*total*	12	282.79	44.77	238.24	391.30
		dissolved	13	279.07	50.12	222.21	409.12
Mid Nettle		*total*	13	198.73	25.02	153.34	249.52
		dissolved	12	193.29	22.85	149.62	241.15
Upper Nettle		*total*	13	196.23	27.64	163.88	267.59
		dissolved	13	198.90	25.61	169.05	267.29
Stream 10		*total*	13	129.27	17.28	109.75	166.01
		dissolved	13	131.66	20.50	105.34	172.24
Jeffersonville		*total*	4	1599.31	379.59	1269.14	2136.08
		dissolved	4	1576.43	368.83	1230.94	2088.06
Browns River		*total*	3	1935.65	1020.51	1219.50	3104.15
		dissolved	3	1967.74	1008.88	1245.76	3120.50
Milton		*total*	4	2237.62	572.52	1532.31	2925.45
		dissolved	4	2204.39	557.55	1498.54	2839.32

Table B-5. Summary statistics for each analyte by media and site.

Li

Lithium Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	3.48	1.61	1.32	5.22
		dissolved	3	2.38	0.93	1.34	3.12
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	1.87	0.82	1.10	2.74
		dissolved	3	1.89	0.89	1.08	2.84
	deep	*total*	3	0.92	0.38	0.50	1.25
		dissolved	3	0.91	0.40	0.47	1.26
Stream 10	shallow	*total*	3	1.28	1.15	0.34	2.56
		dissolved	2	0.63	0.48	0.30	0.97
	deep	*total*	2	3.62	2.92	1.56	5.68
		dissolved	2	3.59	2.85	1.58	5.61
Stream Water							
Nettle Weir		*total*	12	0.36	0.07	0.27	0.52
		dissolved	13	0.32	0.04	0.27	0.40
Mid Nettle		*total*	13	0.42	0.06	0.33	0.54
		dissolved	12	0.42	0.05	0.33	0.50
Upper Nettle		*total*	13	0.40	0.05	0.30	0.46
		dissolved	13	0.40	0.06	0.30	0.48
Stream 10		*total*	13	1.04	0.16	0.79	1.29
		dissolved	13	1.05	0.17	0.80	1.34
Jeffersonville		*total*	4	0.55	0.14	0.40	0.74
		dissolved	4	0.37	0.07	0.29	0.45
Browns River		*total*	3	0.35	0.09	0.24	0.42
		dissolved	3	0.29	0.11	0.21	0.42
Milton		*total*	4	0.48	0.10	0.40	0.64
		dissolved	4	0.38	0.09	0.28	0.49

Table B-5. Summary statistics for each analyte by media and site.

Mn

Manganese Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	133.42	93.76	23.29	248.97
		dissolved	3	149.13	91.83	55.79	239.37
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	32.30	8.52	24.44	41.35
		dissolved	3	28.38	4.46	23.71	32.60
	deep	*total*	3	13.05	4.17	8.85	17.20
		dissolved	3	13.06	4.02	9.08	17.12
Stream 10	shallow	*total*	3	26.08	10.15	14.86	34.62
		dissolved	2	25.59	14.06	15.65	35.53
	deep	*total*	2	31.65	16.30	20.12	43.17
		dissolved	2	32.44	16.07	21.07	43.80

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	13.79	11.92	3.43	43.70
	dissolved	13	3.14	1.04	1.91	5.49
Mid Nettle	*total*	13	14.61	8.99	4.35	39.07
	dissolved	12	8.48	4.02	3.17	18.20
Upper Nettle	*total*	13	49.47	25.89	14.17	106.39
	dissolved	13	46.27	23.84	13.74	97.67
Stream 10	*total*	13	33.50	8.96	25.51	54.63
	dissolved	13	33.96	9.32	25.18	55.32
Jeffersonville	*total*	4	62.18	50.28	25.43	135.55
	dissolved	4	1.87	0.94	1.24	3.26
Browns River	*total*	3	106.12	108.31	1.09	217.43
	dissolved	3	28.66	48.13	0.52	84.24
Milton	*total*	4	42.95	21.94	21.53	69.13
	dissolved	4	2.86	2.51	0.90	6.25

Table B-5. Summary statistics for each analyte by media and site.

Mg2

Magnesium (UVM Env. Test. Lab) Units are in (mg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*dissolved*	10	0.64	0.31	0.16	1.17
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	0.39	0.20	0.24	0.68
	deep	*dissolved*	8	0.24	0.08	0.17	0.42
Stream 10	shallow	*dissolved*	6	0.12	0.03	0.07	0.15
	deep	*dissolved*	3	0.21	0.08	0.13	0.29

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*dissolved*	13	0.28	0.06	0.19	0.38
Mid Nettle	*dissolved*	13	0.19	0.03	0.14	0.26
Upper Nettle	*dissolved*	13	0.19	0.03	0.13	0.26
Stream 10	*dissolved*	13	0.13	0.05	0.06	0.21
Jeffersonville	*dissolved*	3	1.96	0.40	1.64	2.40
Browns River	*dissolved*	3	2.09	0.98	1.38	3.21
Milton	*dissolved*	3	2.70	0.33	2.47	3.07

Table B-5. Summary statistics for each analyte by media and site.

Mo

Molybdenum Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.025	0.006	0.018	0.032
		dissolved	3	0.036	0.017	0.025	0.056
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.004	0.003	0.001	0.007
		dissolved	3	0.011	0.002	0.008	0.012
	deep	*total*	3	0.002	0.001	0.000	0.003
		dissolved	3	0.033	0.036	0.000	0.072
Stream 10	shallow	*total*	3	0.028	0.003	0.026	0.031
		dissolved	2	0.042	0.024	0.026	0.059
	deep	*total*	2	0.010	0.010	0.002	0.017
		dissolved	2	0.019	0.017	0.006	0.031

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.008	0.006	0.000	0.016
	dissolved	13	0.017	0.015	0.000	0.048
Mid Nettle	*total*	13	0.005	0.004	0.000	0.011
	dissolved	12	0.013	0.019	0.000	0.066
Upper Nettle	*total*	13	0.008	0.007	0.000	0.023
	dissolved	13	0.012	0.010	0.000	0.032
Stream 10	*total*	13	0.002	0.003	0.000	0.009
	dissolved	13	0.009	0.013	0.000	0.037
Jeffersonville	*total*	4	0.061	0.027	0.026	0.090
	dissolved	4	0.097	0.049	0.041	0.158
Browns River	*total*	3	0.067	0.037	0.024	0.092
	dissolved	3	0.086	0.043	0.052	0.135
Milton	*total*	4	0.130	0.071	0.052	0.197
	dissolved	4	0.158	0.093	0.055	0.266

Table B-5. Summary statistics for each analyte by media and site.

Hg

Mercury Units are in (ng/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	13	20.1	7.2	9.3	34.9
		dissolved	5	14.6	2.7	11.4	17.5
	deep	*total*	4	3.0	1.1	1.9	4.5
Upper Nettle	shallow	*total*	9	3.5	1.8	1.1	7.7
		dissolved	3	2.3	1.0	1.1	2.9
	deep	*total*	10	1.1	1.7	0.1	5.6
		dissolved	3	0.3	0.4	0.1	0.8
Stream 10	shallow	*total*	6	16.6	7.4	7.7	29.4
		dissolved	4	9.5	1.9	7.7	11.7
	deep	*total*	4	6.6	3.3	2.5	10.2
		dissolved	2	5.2	1.7	4.0	6.4

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	3.1	1.4	1.0	5.9†
	dissolved	13	2.2	0.8	1.0	3.5
Mid Nettle	*total*	13	3.2	1.2	0.9	5.0
	dissolved	13	2.2	0.8	0.9	3.3
Upper Nettle	*total*	13	3.5	1.3	1.5	5.5
	dissolved	13	2.4	0.9	1.0	3.6
Stream 10	*total*	13	4.0	1.0	2.2	6.2
	dissolved	12	3.0	0.7	1.5	4.1
Jeffersonville	*total*	4	4.9	1.7	3.5	7.4
	dissolved	4	2.1	1.1	1.3	3.7
Browns River	*total*	4	5.6	5.7	0.9	13.7
	dissolved	4	2.2	2.0	0.9	5.1
Milton	*total*	4	2.9	0.4	2.6	3.4
	dissolved	4	1.3	0.3	1.0	1.7

† A value of 9.2 ng/L was determined to be an outlier and was excluded from analysis. See Table B-4 for full data set.

Table B-5. Summary statistics for each analyte by media and site.

Ni

Nickel Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	2.79	1.29	1.34	4.49
		dissolved	3	2.72	1.48	1.37	4.30
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	2.71	1.36	1.55	4.21
		dissolved	3	2.74	1.51	1.40	4.38
	deep	*total*	3	1.56	0.23	1.40	1.83
		dissolved	3	1.58	0.29	1.41	1.91
Stream 10	shallow	*total*	3	1.63	0.66	1.18	2.39
		dissolved	2	1.86	0.80	1.29	2.43
	deep	*total*	2	1.06	0.48	0.72	1.40
		dissolved	2	1.10	0.41	0.81	1.39
Stream Water							
Nettle Weir		*total*	12	0.98	0.20	0.75	1.38
		dissolved	13	0.88	0.16	0.70	1.22
Mid Nettle		*total*	13	1.17	0.21	0.92	1.60
		dissolved	12	1.15	0.18	0.88	1.47
Upper Nettle		*total*	13	1.22	0.23	0.89	1.60
		dissolved	13	1.21	0.21	0.91	1.51
Stream 10		*total*	13	1.09	0.08	0.94	1.23
		dissolved	13	1.10	0.07	0.94	1.19
Jeffersonville		*total*	4	2.50	0.90	1.98	3.84
		dissolved	4	1.58	0.25	1.27	1.87
Browns River		*total*	3	1.07	0.31	0.72	1.31
		dissolved	3	0.90	0.26	0.64	1.17
Milton		*total*	4	1.81	0.28	1.59	2.21
		dissolved	4	1.40	0.17	1.21	1.58

Table B-5. Summary statistics for each analyte by media and site.

Nd

Neodymium Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.41	0.09	0.31	0.53
		dissolved	3	0.36	0.04	0.31	0.38
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	1.51	0.88	0.50	2.13
		dissolved	3	1.11	0.60	0.50	1.69
	deep	*total*	3	10.36	8.33	0.97	16.82
		dissolved	3	10.27	8.42	0.80	16.91
Stream 10	shallow	*total*	3	1.45	0.52	0.94	1.98
		dissolved	2	1.66	0.32	1.44	1.89
	deep	*total*	2	1.00	0.32	0.78	1.23
		dissolved	2	0.97	0.34	0.73	1.22
Stream Water							
Nettle Weir		*total*	12	0.99	0.51	0.40	1.90
		dissolved	13	0.64	0.25	0.28	1.04
Mid Nettle		*total*	13	1.27	0.47	0.51	2.04
		dissolved	12	1.15	0.37	0.53	1.70
Upper Nettle		*total*	13	1.42	0.54	0.50	2.16
		dissolved	13	1.28	0.46	0.50	1.81
Stream 10		*total*	13	2.14	0.25	1.60	2.62
		dissolved	13	2.10	0.20	1.66	2.41
Jeffersonville		*total*	4	0.82	0.35	0.57	1.34
		dissolved	4	0.21	0.06	0.17	0.28
Browns River		*total*	3	1.44	1.58	0.30	3.24
		dissolved	3	0.66	0.78	0.08	1.54
Milton		*total*	4	0.42	0.18	0.20	0.62
		dissolved	4	0.11	0.04	0.08	0.17

Table B-5. Summary statistics for each analyte by media and site.

Peak Absorption

Measured on a spectrophotometer.

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*dissolved*	10	0.409	0.120	0.271	0.563
	deep	*dissolved*	1	0.017	.	0.017	0.017
Upper Nettle	shallow	*dissolved*	7	0.019	0.012	0.010	0.044
	deep	*dissolved*	9	0.028	0.046	0.005	0.147
Stream 10	shallow	*dissolved*	6	0.220	0.073	0.142	0.328
	deep	*dissolved*	3	0.065	0.029	0.046	0.098

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*dissolved*	13	0.041	0.018	0.012	0.067
Mid Nettle	*dissolved*	13	0.041	0.018	0.010	0.071
Upper Nettle	*dissolved*	13	0.056	0.028	0.016	0.114
Stream 10	*dissolved*	13	0.035	0.009	0.016	0.050
Jeffersonville	*dissolved*	3	0.063	0.033	0.037	0.100
Browns River	*dissolved*	3	0.025	0.019	0.011	0.046
Milton	*dissolved*	3	0.033	0.007	0.026	0.040

Table B-5. Summary statistics for each analyte by media and site.

NO_3-N

Nitrate

Units are in (mg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*dissolved*	10	4.286	3.830	0.133	12.285
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	1.626	1.717	0.270	5.261
	deep	*dissolved*	8	0.941	1.484	0.001	3.927
Stream 10	shallow	*dissolved*	6	1.359	1.444	0.041	3.116
	deep	*dissolved*	3	1.240	1.982	0.063	3.528

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*dissolved*	13	0.040	0.065	0.001	0.176
Mid Nettle	*dissolved*	13	0.084	0.120	0.001	0.389
Upper Nettle	*dissolved*	13	0.062	0.091	0.001	0.237
Stream 10	*dissolved*	13	0.112	0.176	0.001	0.642
Jeffersonville	*dissolved*	3	0.135	0.038	0.100	0.175
Browns River	*dissolved*	3	0.202	0.103	0.083	0.267
Milton	*dissolved*	3	0.281	0.131	0.186	0.430

Table B-5. Summary statistics for each analyte by media and site.

pH

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	12	5.55	0.65	4.68	6.58
	deep	*total*	3	6.65	0.51	6.06	6.97
Upper Nettle	shallow	*total*	8	5.98	0.43	5.47	6.70
	deep	*total*	9	6.06	0.52	5.45	6.86
Stream 10	shallow	*total*	6	4.71	0.48	4.22	5.49
	deep	*total*	3	4.90	0.34	4.57	5.24
Stream Water							
Nettle Weir		*total*	13	6.13	0.15	5.88	6.31
Mid Nettle		*total*	13	5.54	0.19	5.10	5.80
Upper Nettle		*total*	13	5.57	0.14	5.35	5.79
Stream 10		*total*	13	4.43	0.04	4.37	4.49
Jeffersonville		*total*	3	7.13	0.26	6.91	7.41
Browns River		*total*	3	7.20	0.26	7.02	7.50
Milton		*total*	3	7.29	0.10	7.21	7.41

Table B-5. Summary statistics for each analyte by media and site.

Peak Wavelength

Measured on a spectrophotometer.

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*dissolved*	10	326.2	3.7	321.0	330.5
	deep	*dissolved*	1	360.0	.	360.0	360.0
Upper Nettle	shallow	*dissolved*	7	363.1	17.5	350.5	400.0
	deep	*dissolved*	9	395.3	25.4	348.5	427.0
Stream 10	shallow	*dissolved*	6	334.4	8.0	326.0	348.5
	deep	*dissolved*	3	348.8	3.8	344.5	351.0
Stream Water							
Nettle Weir		*dissolved*	13	348.6	5.1	340.0	360.0
Mid Nettle		*dissolved*	13	349.8	6.0	340.0	360.0
Upper Nettle		*dissolved*	13	348.4	5.0	340.0	360.0
Stream 10		*dissolved*	13	350.3	3.8	344.0	360.0
Jeffersonville		*dissolved*	3	347.5	3.3	344.0	350.5
Browns River		*dissolved*	3	387.8	56.6	350.5	453.0
Milton		*dissolved*	3	350.7	0.3	350.5	351.0

Table B-5. Summary statistics for each analyte by media and site.

Rb

Rubidium

Units are in (μg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	5.78	4.16	1.85	11.58
		dissolved	3	5.99	4.60	2.92	11.28
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	4.13	3.53	0.88	7.88
		dissolved	3	4.15	3.61	0.84	8.00
	deep	*total*	3	0.48	0.31	0.16	0.77
		dissolved	3	0.48	0.30	0.16	0.76
Stream 10	shallow	*total*	3	8.31	6.14	1.48	13.35
		dissolved	2	5.92	6.22	1.53	10.32
	deep	*total*	2	1.97	0.26	1.79	2.16
		dissolved	2	1.96	0.24	1.79	2.13

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.73	0.21	0.49	1.24
	dissolved	13	0.67	0.20	0.48	1.22
Mid Nettle	*total*	13	0.61	0.22	0.25	1.18
	dissolved	12	0.59	0.21	0.24	1.10
Upper Nettle	*total*	13	0.58	0.24	0.30	1.25
	dissolved	13	0.56	0.22	0.30	1.18
Stream 10	*total*	13	0.16	0.08	0.09	0.35
	dissolved	13	0.15	0.08	0.08	0.35
Jeffersonville	*total*	4	1.22	0.37	0.91	1.74
	dissolved	4	1.06	0.31	0.73	1.47
Browns River	*total*	3	0.87	0.19	0.65	1.01
	dissolved	3	0.83	0.09	0.72	0.90
Milton	*total*	4	1.40	0.45	1.00	2.01
	dissolved	4	1.26	0.43	0.79	1.80

Table B-5. Summary statistics for each analyte by media and site.

K^+

Potassium

Units are in (mg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*dissolved*	10	1.98	0.82	0.91	3.09
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	1.10	0.48	0.65	2.04
	deep	*dissolved*	8	0.65	0.19	0.39	1.05
Stream 10	shallow	*dissolved*	6	1.91	1.25	0.75	3.10
	deep	*dissolved*	3	1.06	0.13	0.97	1.20

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*dissolved*	13	0.55	0.31	0.36	1.45
Mid Nettle	*dissolved*	13	0.44	0.07	0.37	0.65
Upper Nettle	*dissolved*	13	0.44	0.08	0.38	0.67
Stream 10	*dissolved*	13	0.45	0.08	0.30	0.54
Jeffersonville	*dissolved*	3	1.02	0.07	0.94	1.08
Browns River	*dissolved*	3	1.32	0.26	1.04	1.55
Milton	*dissolved*	3	1.58	0.17	1.39	1.69

Table B-5. Summary statistics for each analyte by media and site.

Si

Silica

Units are in (mg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*dissolved*	10	3.32	2.18	0.94	7.67
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	1.72	1.03	0.85	3.84
	deep	*dissolved*	8	1.57	1.19	0.44	3.91
Stream 10	shallow	*dissolved*	6	0.90	0.92	0.13	2.70
	deep	*dissolved*	3	1.26	0.68	0.48	1.71
Stream Water							
Nettle Weir		*dissolved*	13	0.94	0.24	0.65	1.41
Mid Nettle		*dissolved*	13	0.67	0.12	0.51	0.92
Upper Nettle		*dissolved*	13	0.76	0.15	0.55	1.04
Stream 10		*dissolved*	13	0.51	0.11	0.33	0.78
Jeffersonville		*dissolved*	3	1.13	0.29	0.85	1.42
Browns River		*dissolved*	3	1.17	0.32	0.83	1.47
Milton		*dissolved*	3	1.11	0.14	0.95	1.21

Table B-5. Summary statistics for each analyte by media and site.

Sm

Samarium

Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.088	0.022	0.059	0.113
		dissolved	3	0.072	0.010	0.060	0.079
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.283	0.168	0.096	0.420
		dissolved	3	0.203	0.111	0.090	0.313
	deep	*total*	3	1.418	1.206	0.099	2.465
		dissolved	3	1.418	1.237	0.073	2.507
Stream 10	shallow	*total*	3	0.280	0.103	0.182	0.388
		dissolved	2	0.319	0.055	0.281	0.358
	deep	*total*	2	0.205	0.062	0.161	0.248
		dissolved	2	0.188	0.061	0.145	0.231
Stream Water							
Nettle Weir		*total*	12	0.195	0.095	0.079	0.368
		dissolved	13	0.125	0.044	0.057	0.195
Mid Nettle		*total*	13	0.241	0.089	0.096	0.379
		dissolved	12	0.220	0.074	0.108	0.344
Upper Nettle		*total*	13	0.274	0.099	0.108	0.408
		dissolved	13	0.245	0.084	0.105	0.342
Stream 10		*total*	13	0.399	0.045	0.291	0.467
		dissolved	13	0.389	0.037	0.300	0.439
Jeffersonville		*total*	4	0.154	0.075	0.108	0.266
		dissolved	4	0.040	0.012	0.030	0.055
Browns River		*total*	3	0.300	0.327	0.060	0.672
		dissolved	3	0.129	0.151	0.017	0.301
Milton		*total*	4	0.084	0.038	0.038	0.127
		dissolved	4	0.024	0.008	0.019	0.036

Table B-5. Summary statistics for each analyte by media and site.

Na^+

Sodium Units are in (mg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*dissolved*	10	0.43	0.25	0.16	1.04
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	0.33	0.22	0.14	0.76
	deep	*dissolved*	8	0.44	0.23	0.24	0.96
Stream 10	shallow	*dissolved*	6	0.44	0.14	0.28	0.67
	deep	*dissolved*	3	0.48	0.14	0.35	0.63
Stream Water							
Nettle Weir		*dissolved*	13	0.50	0.14	0.33	0.78
Mid Nettle		*dissolved*	13	0.39	0.09	0.28	0.55
Upper Nettle		*dissolved*	13	0.39	0.11	0.27	0.53
Stream 10		*dissolved*	13	0.32	0.07	0.20	0.38
Jeffersonville		*dissolved*	3	3.18	0.70	2.39	3.74
Browns River		*dissolved*	3	4.45	3.05	2.05	7.88
Milton		*dissolved*	3	5.29	1.19	4.19	6.55

Table B-5. Summary statistics for each analyte by media and site.

Ag

Silver Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.0045	0.0019	0.0027	0.0069
		dissolved	3	0.0015	0.0005	0.001	0.0019
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.0029	0.0051	0	0.0088
		dissolved	3	0.0020	0.0028	0	0.0052
	deep	*total*	3	0.0000	0.0001	0	0.0001
		dissolved	3	0.0020	0.0021	0	0.0041
Stream 10	shallow	*total*	3	0.0034	0.0014	0.0017	0.0043
		dissolved	2	0.0012	0.0016	0	0.0023
	deep	*total*	2	0.0018	0.0004	0.0015	0.0021
		dissolved	2	0.0016	0.0014	0.0006	0.0026
Stream Water							
Nettle Weir		*total*	12	0.0006	0.0007	0	0.0022
		dissolved	13	0.0009	0.0007	0	0.0019
Mid Nettle		*total*	13	0.0002	0.0005	0	0.0017
		dissolved	12	0.0005	0.0012	0	0.0042
Upper Nettle		*total*	13	0.0002	0.0004	0	0.0011
		dissolved	13	0.0000	0.0001	0	0.0002
Stream 10		*total*	13	0.0000	0.0000	0	0.0001
		dissolved	13	0.0003	0.0005	0	0.0016
Jeffersonville		*total*	4	0.0008	0.0013	0	0.0027
		dissolved	4	0.0004	0.0005	0	0.0011
Browns River		*total*	3	0.0016	0.0014	0	0.0027
		dissolved	3	0.0005	0.0005	0	0.0009
Milton		*total*	4	0.0009	0.0008	0	0.0017
		dissolved	4	0.0002	0.0002	0	0.0004

Table B-5. Summary statistics for each analyte by media and site.

SO_4-S

Sulfate Units are in (mg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*dissolved*	10	1.26	0.47	0.42	1.95
	deep	*dissolved*	0	.	.	.	.
Upper Nettle	shallow	*dissolved*	7	1.57	0.51	0.58	2.08
	deep	*dissolved*	8	1.35	0.30	0.73	1.63
Stream 10	shallow	*dissolved*	6	1.29	0.26	0.92	1.54
	deep	*dissolved*	3	1.77	0.55	1.25	2.34
Stream Water							
Nettle Weir		*total*	13	1.43	0.22	1.06	1.70
Mid Nettle		*total*	13	1.32	0.20	0.99	1.72
Upper Nettle		*total*	13	1.34	0.17	1.06	1.65
Stream 10		*total*	13	1.46	0.15	1.22	1.63
Jeffersonville		*total*	3	1.95	0.15	1.79	2.08
Browns River		*total*	3	2.12	0.23	1.92	2.37
Milton		*total*	3	2.43	0.16	2.24	2.53

Table B-5. Summary statistics for each analyte by media and site.

Sr

Strontium Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	40.26	19.66	16.53	63.93
		dissolved	3	36.92	23.07	16.45	61.93
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	32.15	22.14	12.10	55.91
		dissolved	3	32.48	23.29	11.62	57.61
	deep	*total*	3	11.66	5.71	7.43	18.16
		dissolved	3	11.66	5.63	7.57	18.08
Stream 10	shallow	*total*	3	9.06	5.01	3.34	12.70
		dissolved	2	7.48	5.69	3.46	11.51
	deep	*total*	2	13.48	11.49	5.36	21.61
		dissolved	2	13.63	11.06	5.81	21.45
Stream Water							
Nettle Weir		*total*	12	14.33	2.16	11.43	18.90
		dissolved	13	13.95	2.34	10.83	19.54
Mid Nettle		*total*	13	11.16	1.28	9.56	14.13
		dissolved	12	11.00	1.32	9.30	13.81
Upper Nettle		*total*	13	11.99	1.67	9.56	16.15
		dissolved	13	11.99	1.51	9.78	15.83
Stream 10		*total*	13	2.17	0.10	2.07	2.41
		dissolved	13	2.19	0.13	2.01	2.50
Jeffersonville		*total*	4	54.48	12.73	41.34	71.78
		dissolved	4	54.43	13.06	41.01	72.17
Browns River		*total*	3	49.83	24.29	31.65	77.42
		dissolved	3	50.36	24.23	31.92	77.80
Milton		*total*	4	66.90	18.16	43.08	87.03
		dissolved	4	66.47	17.25	43.51	85.24

Table B-5. Summary statistics for each analyte by media and site.

Ti

Titanium

Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	16.50	5.81	10.33	25.74
		dissolved	3	11.62	2.39	9.50	14.21
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	2.63	1.82	0.82	4.45
		dissolved	3	1.13	0.73	0.61	1.96
	deep	*total*	3	0.42	0.09	0.33	0.49
		dissolved	3	0.33	0.06	0.28	0.40
Stream 10	shallow	*total*	3	7.66	1.36	6.17	8.84
		dissolved	2	5.62	0.56	5.22	6.01
	deep	*total*	2	5.19	1.07	4.44	5.95
		dissolved	2	3.32	0.09	3.26	3.39
Stream Water							
Nettle Weir		*total*	12	3.26	2.91	1.09	11.14
		dissolved	13	0.82	0.30	0.42	1.41
Mid Nettle		*total*	13	1.24	0.48	0.72	2.38
		dissolved	12	0.67	0.18	0.39	0.96
Upper Nettle		*total*	13	1.24	0.38	0.54	1.83
		dissolved	13	0.85	0.22	0.50	1.27
Stream 10		*total*	13	0.57	0.21	0.39	1.03
		dissolved	13	0.47	0.12	0.27	0.64
Jeffersonville		*total*	4	5.20	3.03	2.82	9.44
		dissolved	4	0.76	0.04	0.71	0.81
Browns River		*total*	3	7.84	7.43	0.72	15.56
		dissolved	3	3.58	4.89	0.65	9.22
Milton		*total*	4	4.23	2.34	1.47	6.51
		dissolved	4	0.69	0.07	0.60	0.76

Table B-5. Summary statistics for each analyte by media and site.

Tl

Thallium

Units are in (µg/L)

			N	Mean	Std Dev	Minimum	Maximum
Soil Water							
Mid Nettle	shallow	*total*	5	0.026	0.015	0.010	0.046
		dissolved	3	0.028	0.016	0.018	0.046
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.003	0.001	0.002	0.003
		dissolved	3	0.004	0.001	0.003	0.005
	deep	*total*	3	0.001	0.001	0.000	0.002
		dissolved	3	0.003	0.003	0.001	0.006
Stream 10	shallow	*total*	3	0.041	0.017	0.025	0.058
		dissolved	2	0.033	0.017	0.021	0.045
	deep	*total*	2	0.016	0.000	0.016	0.017
		dissolved	2	0.020	0.001	0.019	0.020
Stream Water							
Nettle Weir		*total*	12	0.003	0.001	0.001	0.006
		dissolved	13	0.004	0.002	0.001	0.008
Mid Nettle		*total*	13	0.003	0.002	0.001	0.006
		dissolved	12	0.004	0.001	0.002	0.007
Upper Nettle		*total*	13	0.005	0.002	0.002	0.008
		dissolved	13	0.005	0.002	0.002	0.009
Stream 10		*total*	13	0.010	0.002	0.008	0.015
		dissolved	13	0.011	0.002	0.008	0.016
Jeffersonville		*total*	4	0.008	0.002	0.006	0.010
		dissolved	4	0.007	0.002	0.005	0.010
Browns River		*total*	3	0.012	0.006	0.008	0.018
		dissolved	3	0.010	0.004	0.006	0.014
Milton		*total*	4	0.009	0.004	0.005	0.014
		dissolved	4	0.009	0.005	0.004	0.016

Table B-5. Summary statistics for each analyte by media and site.

V

Vanadium

Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.944	0.168	0.771	1.129
		dissolved	3	0.784	0.082	0.724	0.877
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.132	0.017	0.114	0.148
		dissolved	3	0.107	0.043	0.063	0.149
	deep	*total*	3	0.050	0.033	0.018	0.084
		dissolved	3	0.051	0.034	0.019	0.087
Stream 10	shallow	*total*	3	0.731	0.048	0.690	0.784
		dissolved	2	0.708	0.014	0.698	0.719
	deep	*total*	2	0.350	0.100	0.280	0.421
		dissolved	2	0.315	0.084	0.256	0.375

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.201	0.142	0.078	0.569
	dissolved	13	0.102	0.039	0.038	0.158
Mid Nettle	*total*	13	0.105	0.041	0.045	0.198
	dissolved	12	0.085	0.027	0.046	0.124
Upper Nettle	*total*	13	0.118	0.045	0.050	0.185
	dissolved	13	0.101	0.035	0.042	0.152
Stream 10	*total*	13	0.090	0.044	0.037	0.185
	dissolved	13	0.087	0.039	0.046	0.179
Jeffersonville	*total*	4	0.474	0.297	0.287	0.913
	dissolved	4	0.145	0.034	0.109	0.184
Browns River	*total*	3	0.535	0.368	0.192	0.924
	dissolved	3	0.338	0.316	0.128	0.702
Milton	*total*	4	0.367	0.139	0.252	0.535
	dissolved	4	0.165	0.038	0.132	0.201

Table B-5. Summary statistics for each analyte by media and site.

W

Tungsten

Units are in (µg/L)

Soil Water

			N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	0.0009	0.0012	0.0000	0.0024
		dissolved	3	0.0128	0.0209	0.0000	0.0369
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	0.0000	0.0000	0.0000	0.0000
		dissolved	3	0.0122	0.0087	0.0045	0.0217
	deep	*total*	3	0.0017	0.0029	0.0000	0.0051
		dissolved	3	0.0627	0.0653	0.0000	0.1304
Stream 10	shallow	*total*	3	0.0075	0.0038	0.0034	0.0109
		dissolved	2	0.0535	0.0537	0.0155	0.0914
	deep	*total*	2	0.0008	0.0011	0.0000	0.0015
		dissolved	2	0.0307	0.0257	0.0125	0.0488

Stream Water

		N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	0.0005	0.0009	0.0000	0.0024
	dissolved	13	0.0183	0.0296	0.0000	0.0878
Mid Nettle	*total*	13	0.0014	0.0027	0.0000	0.0079
	dissolved	12	0.0154	0.0317	0.0000	0.1132
Upper Nettle	*total*	13	0.0003	0.0011	0.0000	0.0039
	dissolved	13	0.0069	0.0098	0.0000	0.0263
Stream 10	*total*	13	0.0000	0.0001	0.0000	0.0005
	dissolved	13	0.0107	0.0183	0.0000	0.0507
Jeffersonville	*total*	4	0.0000	0.0000	0.0000	0.0000
	dissolved	4	0.0060	0.0063	0.0000	0.0140
Browns River	*total*	3	0.0000	0.0000	0.0000	0.0000
	dissolved	3	0.0038	0.0066	0.0000	0.0114
Milton	*total*	4	0.0002	0.0003	0.0000	0.0006
	dissolved	4	0.0086	0.0059	0.0000	0.0129

Table B-5. Summary statistics for each analyte by media and site.

Zn

Zinc Units are in (µg/L)

Soil Water

Site	Depth	Fraction	N	Mean	Std Dev	Minimum	Maximum
Mid Nettle	shallow	*total*	5	27.36	15.89	11.67	48.92
		dissolved	3	29.61	17.10	13.08	47.22
	deep	*total*	0	.	.	.	.
Upper Nettle	shallow	*total*	3	32.81	19.57	14.78	53.62
		dissolved	3	32.99	20.45	13.87	54.55
	deep	*total*	3	17.91	5.35	14.72	24.09
		dissolved	3	17.97	5.53	14.52	24.34
Stream 10	shallow	*total*	3	9.27	4.63	5.04	14.22
		dissolved	2	10.13	6.30	5.67	14.58
	deep	*total*	2	40.70	25.69	22.53	58.86
		dissolved	2	43.56	24.82	26.01	61.11

Stream Water

Site	Fraction	N	Mean	Std Dev	Minimum	Maximum
Nettle Weir	*total*	12	4.51	0.95	3.01	6.26
	dissolved	13	4.07	0.77	2.96	5.39
Mid Nettle	*total*	13	6.17	0.88	4.66	7.68
	dissolved	12	5.88	0.76	5.01	7.28
Upper Nettle	*total*	13	5.86	0.79	4.21	7.15
	dissolved	13	5.98	0.67	5.01	7.13
Stream 10	*total*	13	12.86	1.57	10.59	15.69
	dissolved	13	13.31	2.19	11.07	18.63
Jeffersonville	*total*	4	11.21	17.74	1.40	37.78
	dissolved	4	26.69	52.56	0.24	105.54
Browns River	*total*	3	2.75	2.97	0.45	6.10
	dissolved	3	1.16	1.55	0.20	2.94
Milton	*total*	4	1.10	0.60	0.35	1.81
	dissolved	4	0.33	0.21	0.16	0.62