WATERSHED GROUP MONITORING PROGRAMS: AN INVESTIGATION OF NITRATE CONTAMINATION AT THE STATE BOTANICAL GARDENS OF GEORGIA

David B. Wenner[1], Sue Eggert[2] and Elizabeth Little[3]

AUTHORS: [1]Associate Professor, Department of Geology, [2] Postdoctoral Associate, Department of Entomology, 3 Instructor, Department of Plant Pathology: The University of Georgia, Athens, GA 30602, USA
REFERENCE: *Proceedings of the 2005 Georgia Water Resources Conference*, held April 25-27, 2005, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, GA 30602

Abstract. On April 3, 2004, the Upper Oconee Watershed Network sponsored a community wide stream monitoring event in the Athens Clarke County area. As part of this event, the nitrate concentrations of 46 samples were measured. Although most samples had low values, averaging about 1.5 mg/L (NO_3-N), one sample from the State Botanical Garden of Georgia was anomalously high, in excess of 5.5 mg/L. Follow up investigations of the area revealed that nearby streams and springs were also high. From the pattern of contaminated streams, it appears that the groundwaters underlying an area of about 60 acres may be contaminated. Several springs in the area had nitrate levels >25 mg/L (NO_3-N), more than twice the standard established by the state EPD and federal EPA for drinking water. A major source of this contamination appears to originate from a nearby swine farm. Other possible sources include fertilizer and septic systems at the Botanical Garden and a nearby poultry farm.

INTRODUCTION

During a monitoring event conducted by the Upper Oconee Watershed Network (UOWN) on April 3, 2004 (called: River Rendezvous) in the Athens Clarke County area, a sample from a stream located at the State Botanical Garden of Georgia was found to have a NO_3-N concentration in excess of 5.5 mg/L. This particular sample had the highest nitrate concentration among 46 samples collected and was significantly higher than the average of about 1.5 mg/L in the Athens Clarke County area. This observation sparked a follow up investigation that identified an area of possible groundwater contamination. Details of this study are outlined in this report.

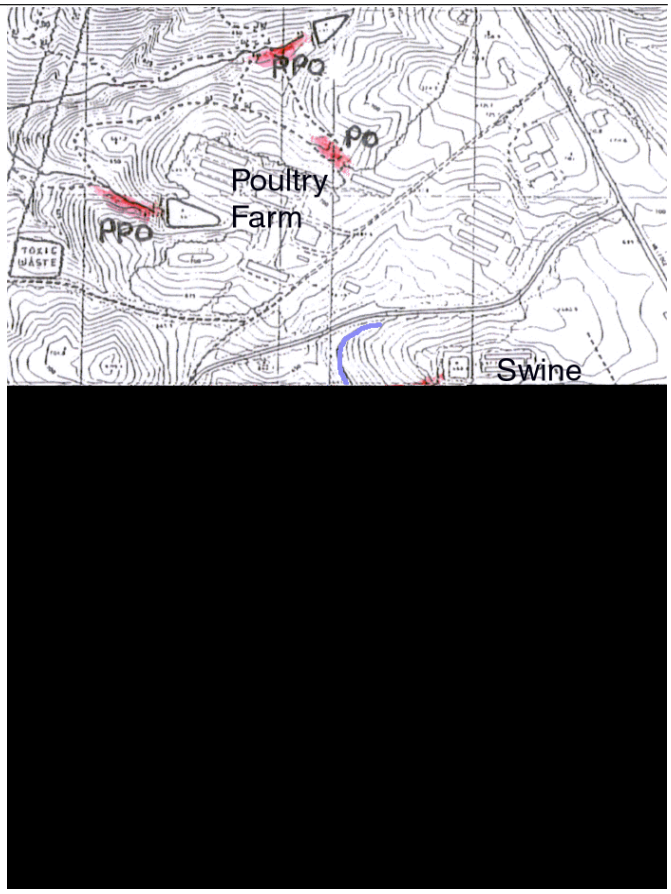

Figure 1. Map of a portion of the State Botanical Garden of Georgia showing sample locations. The site numbers, consistent with the UOWN numbering scheme, contain a prefix MIDO. Areas labeled by EPO and PPO denote erosion and sites of contamination identified by Wharton (1998). Map scale: one inch = 1000 feet. Contour interval is 5 feet.

METHODS

Samples were collected on April 16, 21, and 29 and again on November 6, 2004, from springs and streams in the vicinity of the Orange Trail at the State Botanical Garden of Georgia. The purpose of the sampling was to further document the high nitrate levels originally observed during the River Rendezvous event, and if substantiated, to assess the extent of the problem. Sites sampled in this study are shown in Figure 1.

The April samples were collected during a time when the streams in the area were at low discharge. The November sampling occurred when streams and springs were at somewhat higher discharge. It is thought that the streams during both sampling periods reflect near base flow conditions and thus were supplied largely by groundwater. Thus it can be assumed that the chemical data may reflect the composition of groundwater in areas adjacent to the stream.

Nitrate analyses were done using a Hach model 890 colorimeter with AccuVac ampules designed for the cadmium reduction method. This method of analysis has a precision of 0.1 mg/L and an estimated detection limit of 0.2 mg/L. All analyses included appropriate quality control measures with blanks and standards.

For the April sampling dates, the following sites were examined.

April 16, 2004. Sites MIDO 704 and MIDO 708, two localities that are in the inventory of River Rendezvous sites, were sampled. Site MIDO 704 on Orange Trail Creek is the location where the anomalously high nitrate level was observed during the April 3rd, 2004 River Rendezvous event. A headwater spring at site MIDO 730 was also sampled at this time.

April 21, 2004. Additional sites were sampled on and adjacent to the Orange Trail Creek, including: another spring (MIDO 731), the mouth of a major west flowing tributary (MIDO 732), two additional sites on Orange Trail Creek itself (sites MIDO 733 and MIDO 735), and the headwaters of the tributary of site MIDO 708.

April 29, 2004. Qualitative tests for nitrate using Aquachek test strips were done along the length of the major east flowing tributary (upstream of MIDO 732) of the Orange Trail Creek. Moderate to high levels of nitrate were observed along whole length of this tributary.

In November, all sites shown in Figure 1 were sampled. A new site (MIDO 734) was added to include a tributary further from the site of suspected contamination.

Table 1. Nitrate concentrations in mg/L (reported as NO_3-N) at the Botanical Garden of Georgia in April and November, 2004.

Sample	April	November
MIDO 704	10.2	4.5
MIDO 708	8.4	5.6
MIDO 730	27.5	14.4
MIDO 731	25.5	13.6
MIDO 732	11.7	5.5
MIDO 733	9.6	5.3
MIDO 734		<0.2
MIDO 735	7.5	4.9

DISCUSSION

This investigation clearly shows that the groundwater underlying portions of the State Botanical Garden of Georgia may have anomalously high levels of nitrate. Although it is uncertain how high the nitrate levels are, two groundwater-fed springs discharge waters that are above the EPA maximum contaminant level (MCL) of 10 mg/L NO_3-N for drinking water and substantially above the 1.5 mg/L average for streams and rivers in the Athens-Clarke County area.

Judging by the extent of high nitrate levels observed in the streams and tributaries surveyed, it is estimated that groundwater contamination may encompass about 60 acres, up slope from and to the east of the Orange Trail Creek. The zone of contamination, which presumably includes the whole hill bordered on three sides by streams, was estimated using a transparent dot grid overlay of the topographic map. The top of the hill is occupied by a swine farm operated by the College of Agricultural and Environmental Sciences of The University of Georgia. Potential identifiable sources of this contamination include animal waste lagoons that lie uphill from the Orange Trail Creek a animal waste spray field on the east side of the farm. It is well known that animal waste products can produce high levels of nitrate in groundwaters (e.g., Hallberg and Keeney, 1993).

Another, separate site of groundwater contamination appears to exist in a separate subwatershed in the vicinity of MIDO 730. Regional topography would

seem to preclude groundwater contamination at this site originating from the swine farm. A potential source for this contamination could be the poultry farm, also operated by the College of Agricultural and Environmental Sciences of the University of Georgia. It is difficult to assess the size of the contamination in this area because of the paucity of sample sites. There is no readily identifiable source for the nitrate contamination at the poultry farm, although there may be sites that are now buried or no longer exist.

These contaminated groundwaters are likely responsible for the elevated nitrate levels along the whole course of Orange Trail Creek. A particular problem is that this creek discharges into the Middle Oconee River. During the April sampling period, Orange Trail Creek had nitrate levels of 7.5 mg/L at its mouth, just before entering the Middle Oconee River.

One tributary (MIDO 734) that drains an adjacent subwatershed and is not hydrologically connected to the Swine Center has no measurable amount of nitrate. This site probably reflects the background level of nitrate at the State Botanical Garden where no contamination exists.

Although we only sampled for a short time period, it seems likely that the problem has existed for some time. Previous UOWN samplings at site MIDO 704 on January 31, 2004 (9.5 mg/L), October 18, 2003 (5 mg/L) and April 5, 2003 (5 mg/L) all had relatively high levels of nitrate. It can probably be assumed that the problem will continue for some time in the future.

RECOMMENDED SOLUTION

Although it will be difficult to directly treat the contaminated groundwaters, especially if they are as extensive as suspected, the Orange Trail Creek can probably be remediated before it discharges into the Middle Oconee River. The best approach to solving this problem is to restore the wetlands located near the mouth of the Orange Trail Creek. At present, the creek in this area is largely channelized and thus bypasses an old wetland. It is well known that wetlands can reduce nitrate levels in streams by denitrification.

ACKNOWLEDGMENTS

We thank the many UOWN volunteers who have collected samples during all of our monitoring events.

LITERATURE CITED

G.R. Hallberg and D.R. Keeney. 1993. Nitrate *in* W.M. Alley (Ed.) *Regional Ground-Water Quality*, pp 297-322.

C. Wharton. 1998. Natural Environments of the State Botanical Garden of Georgia. *Special Publication of the State Botanical Garden of Georgia,* 111 p.